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YELLOWSTONE GRIZZLY BEAR INVESTIGATIONS

ANNUAL REPORT OF THE INTERAGENCY STUDY TEAM

1985

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National Park Service
U.S. Forest Service
Montana Fish and Game Department
U.S. Fish and Wildlife Service
Idaho Fish and Game Department
Wyoming Game and Fish Department

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Montana, Fish, Wildlife and Parks Department
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INTRODUCTION

The Interagency Grizzly Bear Study Team (IGBST) was initiated in 1973 and is a cooperative effort of the National Park Service, Forest Service, and since 1974 the States of Idaho, Montana, and Wyoming. The IGBST conducts research that provides information needed by various agencies for immediate and long-term management of grizzly bears (*Ursus arctos horribilis*) inhabiting the Yellowstone area. With increasing demands on most resources in the area, current quantitative data on grizzly bears are required for formulation of management decisions that will insure survival of the population.

Earlier research on grizzlies within Yellowstone National Park provided data for the period 1959-67 (Craighead et al. 1974). However, changes in management operations by the National Park Service since 1967 - mainly the closing of open pit garbage dumps - have markedly changed some food habits (Knight et al 1984), population parameters (Knight and Eberhardt 1985), and growth patterns (Blanchard, in press). Current research efforts are needed to further define and evaluate grizzly bear population dynamics. Objectives of the study are to determine the status and trend of the grizzly bear population, the use of habitats and food items by the bears, and the effects of land management practices on the bear population.

Distribution of grizzly bears within the study area, movement patterns, and habitat use have been largely determined (Knight et al. 1984; Mattson et al., in press) and are now being studied on a monitoring and updating level. Efforts are being concentrated on gathering population parameter data, determining behavior patterns, and assessing the effects of land use practices.

Movement data conclusively indicates that the existence of semi-autonomous population segments is unlikely and that the determination of population size will be difficult due to the average home range sizes of individual bears. Population trend indices appear to be more meaningful and measurable than a number estimate (Eberhardt et al., in press). Research is ongoing in the attempt to document a sensitive and reliable trend index.

Data analyses and summaries presented in this report supersede all previously published data. Study methods are reported by Blanchard (1985).

RESULTS AND DISCUSSION

MOVEMENTS

Since 1975, 118 grizzly bears have been fitted with radio collars and monitored for varying lengths of time. Of these bears, 53 were known or suspected to be dead at the end of the 1985 field season (Table 1); 87% of these deaths were man-caused. Only 19 of the total 118 bears were known to be alive during 1985.

During 1985, four bears were captured five times in agency management actions (Table 2) at five locations within the study area. No bears were captured by the IGBST.

During 1985, 21 grizzlies were radio-monitored for varying lengths of time (Table 3). Of these 21 bears, 10 ceased providing data during the year; 3 were killed or otherwise removed from the population, 5 cast their transmitters, and 2 transmitters apparently failed. Eighteen radio-telemetered grizzly bears were located an average once every 10.1 days.

Aerial radio-tracking methods during 1985 were not designed to gather data for determining annual home ranges of instrumented bears. Therefore, annual ranges could not be calculated for the majority of monitored bears.

Interesting movements of individual grizzlies included: an adult female (No. 116) and her two yearling females (Nos. 117 and 118) transported from West Yellowstone, MT, to separate locations within eastern and southern Yellowstone Park, September 15, 1984. The mother and one yearling were reunited by September 29 and denned together. The second yearling denned alone east of the park and removed her radio at the den during spring. The mother returned to her original home range by June 26, 1985, weaning the 2-year-old with her in the process. This subadult female returned to the area she was transported to in 1984, north of Yellowstone Lake, and remained in that area through the denning period.

Another adult female (No. 86) with her three unweaned 2-year-olds accompanying her, abruptly left her traditional 150 km^2 home range in north-central Yellowstone Park in early September, traveling approximately 40-km airline distance to the Jones Creek drainage, east of the park. The family remained there until mid-October when an encounter with hunters caused her to abruptly return to her traditional home range, still accompanied by her three young.

A subadult female (No. 114), transported once in 1984 and twice in 1985 from the Fishing Bridge area north of Yellowstone Lake, returned every time to her original range. The last release site was 64 airline km from the capture site and took her approximately 15 days to return.

Table 1. Status of instrumented grizzly bears, 1975-85 (n = 118).

Known dead			Suspected dead				
Man caused	Natural	Unknown	Man-caused	Natural	Off air		Active
3	12	77	7	54	1	91	43
4	56	108	11	55	2	92	50
5	65		24		13	96	86
6			31		16	*97	106
8			32		19	98	107
9			75		21	99	110
10			102		23	100	111
14					33	101	114
15					34	103	116
17					35	104	118
18					36	*109	
20					37	112	
22					40	*115	
25					41	*117	
26					42	*119	
27					44	*121	
28					45		
29					48		
30					51		
38					57		
39					*59		
46					61		
47					64		
49					68		
58					*70		
60					71		
62					72		
63					73		
67					74		
69					76		
81					78		
88					79		
90					80		
93					82		
94					83		
95					84		
105					85		
113					87		
120					*89		
39 TOTAL	3 TOTAL	2 TOTAL	7 TOTAL	2 TOTAL		55 TOTAL	10 TOTAL

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*Known alive in 1985.

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Table 2. Grizzly bears captured, 1985.

Bear	Sex	Age	Date trapped	Trap location	Release site	Trapper
114	F	3	07-24	Mary Bay, YNP (mgt)	Two Ocean/Crooked Cr,YNP	YNP
			08-04	Fishing Br., YNP (mgt)	Divide Lk, YNP	YNP
111	M	2	08-04	Sunlight Cr, WY (mgt)	On-site	WY
67	F	4	08-03	Silvergate, MT (mgt)	Mgt kill	MT
20	M	12	08-24	Watkins Cr, MT (mgt)	Mgt kill	MT

Table 3. Grizzly bears monitored during 1985 (n = 21).

Bear	Sex	Age	No. aerial locations	Interval (days)
20	M	12	0	-
43	F	8	14	169
50	F	11	26	202
59	F	7	21	101
67	F	4	11	96
70	M	7	7	36
86	F	15	30	201
97	F	8	0	-
106	F	9	17	155
107	M	6	19	210
109	F	4	6	121
110	M	2	5	80
111	M	2	10	86
114	F	3	50	197
115	M	9	10	56
116	F	11	21	158
117	F	2	3	99
118	F	2	30	189
119	F	4	1	-
120	F	SAd	1	9
121	M	5	9	57

OBSERVATIONS

Unmarked grizzly bears were most frequently observed from the air during June on radio-tracking flights and during August on observation flights (0.61 and 0.91 bears/hour, respectively). The average annual observation rate of unmarked grizzlies for 1985 was 0.19 and 0.69 bears per hour for radio-tracking and observation flights, respectively. Annual variation in aerial observations of unmarked grizzly bears appeared to have no direct relation to number of flights or annual habitat productivity (Fig. 1.) Females with cubs of the year were most frequently observed during June on radio-tracking flights and during August on observation flights (0.10 and 0.09 bears/hour, respectively). Annual flight summeries are listed in the appendix.

POPULATION PARAMETERS

Production

Nine unduplicated females with 16 cubs were monitored during 1985 (Table 4). This was the lowest number of females with cubs observed during the entire study (1973-85), except 1975 when observability was very poor.

By 1985 we had a sample of 11 reproductive cycles for nine females not known to use garbage as a major food source (Table 5). These nine females had a mean reproductive rate of 0.469 compared to 0.800 for two females that relied on garbage as a food source. Mean cycle length was 3.56 years and mean litter size 1.92 cubs, compared to 2.5 years and 2.17 cubs for the two females feeding on garbage. Mean age at first cub production for eight females not using garbage was 6.4 years compared to 5.8 years for four females known to use garbage.

During 1985 over half the litters (55.6%) were comprised of two cubs (Table 6). The average frequency of two-cub litters for the study period 1973-85 was 59%. One-cub litters were more frequent during 1985 than the study average (33.3% compared to 27.5%). One-cub litters occurred more frequently during years of lower habitat productivity (linear regression, r = -.61). Of 6 years for which seasonal habitat productivity was calculated (1977-82), the three least productive springs had a mean frequency of one-cub litters of 24.2% compared to 18.4% for the three most productive springs. Greatest frequency of three-cub litters generally occurred during years of highest habitat productivity.

Survivorship

Survivorship by sex and age class is listed in Table 7. Subadult females have a greater chance of surviving to 5 years than subadult males (36% and 17%, respectively). Subadult females have least chance of surviving their yearling year, while males have least chance of surviving their 2-year-old year. Sexual dimorphism in body size (but not weight) is apparent even as

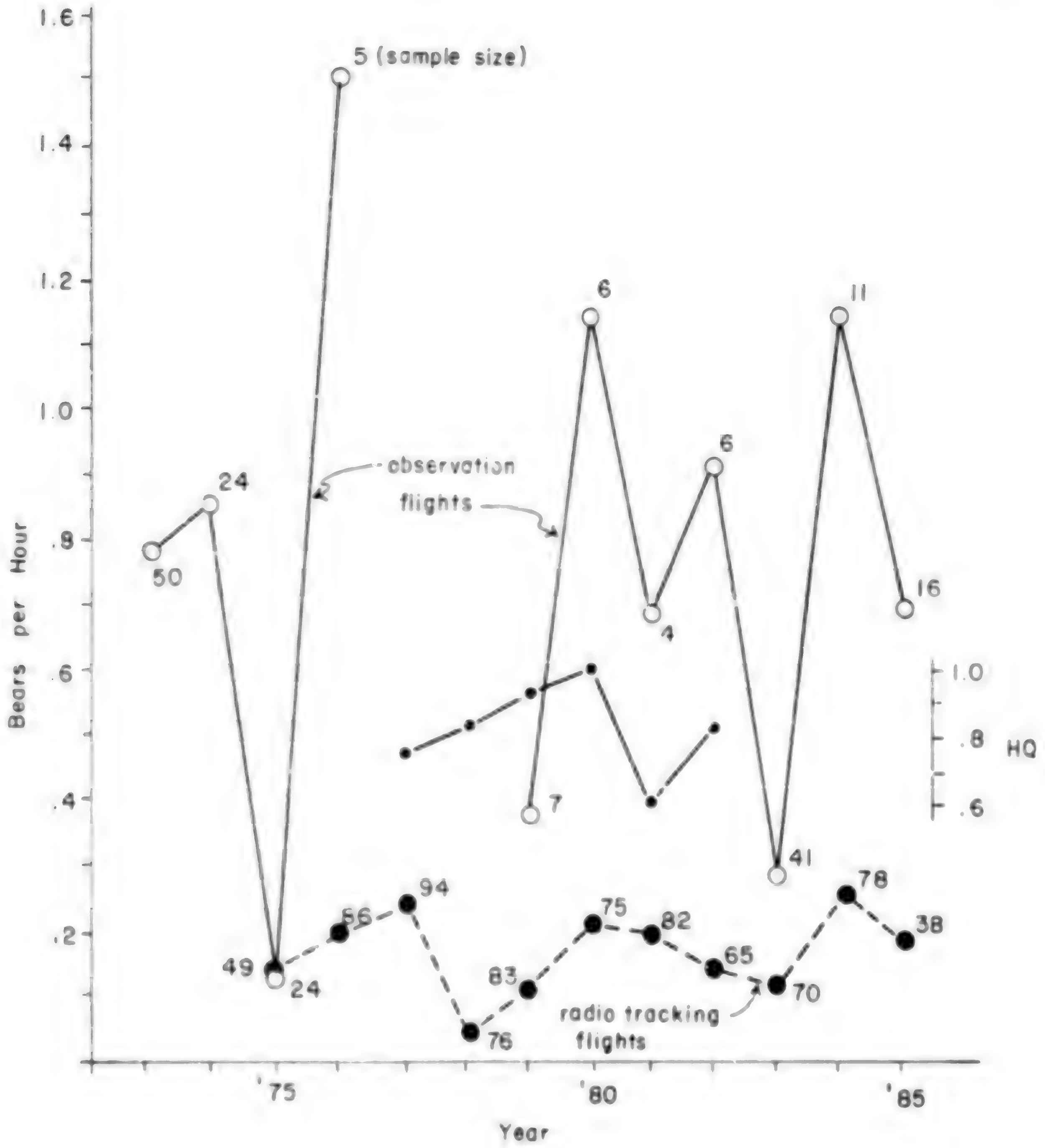

Fig. 1. Annual aerial observation rate of unmarked grizzly bears and annual habitat quality index (HQ).

Table 4. Unduplicated grizzly bear females with cubs of the year, 1973-85.

Year	Females	Cubs	Mean litter size
1973	14	26	1.9
1974	15	26	1.7
1975	4	6	1.5
1976	17	32	1.9
1977	13	25	1.9
1978	9	18	2.0
1979	13	29	2.2
1980	12	23	1.9
1981	13	24	1.9
1982	11	20	1.8
1983	13	22	1.7
1984	17	30	1.8
1985	9	16	1.8

Table 5. Reproductive rates, 1985.

Bear	Total cubs	No. litters	No. known cycles	Cycle lengths	Used to compute reproductive rate[a]	
					No. litters	No. cubs
8	8	4	3	8	3	6
10	7	3	2	5	2	4
	15	7	5	13	5	10

Mean cycle length = 2.50
Mean litter size = 2.17
Reproductive rate = 8/10 = 0.800

Bear	Total cubs	No. litters	No. known cycles	Cycle lengths	No. litters	No. cubs
6	3	2	1	1	1	1
12	4	3	2	4	2	3
13	1	1	1	[b]7	1	1
16	4	2	1	3	1	2
21	4	2	2	3	1	2
26	1	1	1	6	1	1
38	5	2	1	3	1	3
43	2	1	-	-	-	-
50	4	2	1	3	1	2
59	2	1	-	-	-	-
60	2	1	-	-	-	-
68	3	1	-	-	-	-
72	2	1	-	-	-	-
83	2	1	-	-	-	-
86	3	1	-	-	-	-
97	1	1	1	2	-	-
106	2	1	-	-	-	-
116	3	1	-	-	-	-
	48	25	11	32	9	15

Mean cycle length = 3.56
Mean litter size = 1.92
Reproductive rate = 15/32 = 0.469

---

[a] Unweaned cubs cannot be used to compute reproductive rate since their cycle is not complete. No. litters should not exceed No. of cycles.

[b] Cycle is not complete, but at least this length.

Table 6. Annual litter size frequency.

Year	1	(%)	2	(%)	3	(%)
1973	4	(28.6)	8	(57.1)	2	(14.3)
1974	6	(40.0)	7	(46.7)	2	(13.3)
1975	2	(50.0)	2	(50.0)	0	(0.0)
1976	3	(17.7)	13	(76.5)	1	(5.9)
1977	3	(23.1)	8	(61.5)	2	(15.4)
1978	2	(22.2)	5	(55.6)	2	(22.2)
1979	2	(15.4)	6	(46.2)	5	(38.5)
1980	2	(16.7)	9	(75.0)	1	(8.3)
1981	3	(23.1)	8	(61.5)	2	(15.4)
1982	3	(27.3)	7	(63.6)	1	(9.1)
1983	6	(46.2)	5	(38.5)	2	(15.4)
1984	5	(29.4)	11	(64.7)	1	(5.9)
1985	3	(33.3)	5	(55.6)	1	(11.1)
TOTAL	44	(27.5)	94	(58.8)	22	(13.8)

Table 7. Grizzly bear survivorship by sex and age class during 1985.

Age	Sample size			Survivorship		
	Male	All	Female	Male	All	Female
Cub	18	71	14	0.88	0.89	0.93
1	20	54	10	0.80	0.70	0.60
2	21	32	11	0.48	0.63	0.82
3	15	22	7	0.80	0.82	0.88
4	14	23	9	0.64	0.74	0.89
5	10	18	8	0.80	0.83	0.88
6	7	15	8	1.00	0.94	0.75
7	9	17	8	0.89	0.94	1.00
8	8	16	8	1.00	0.94	0.88
9	5	12	7	0.80	0.83	0.86
10	5	12	7	1.00	1.00	1.00
11	6	12	6	1.00	1.00	1.00
12	4	9	5	0.50	0.67	0.80
13	1	6	5	1.00	0.83	0.80
14	5	8	3	0.80	0.88	1.00
15	3	5	2	1.00	1.00	1.00
16	2	4	2	1.00	0.50	0
17	2	2	0	0.50	0.50	-
18	1	2	1	1.00	1.00	1.00
19	1	2	1	1.00	1.00	1.00
20	0	2	2	-	1.00	1.00
21	1	3	2	1.00	1.00	1.00
22	0	2	2	-	0.50	0.50

cubs, becoming significant by the yearling year (Blanchard, in press). Larger male yearlings may compete with smaller female yearlings for available food. This could significantly affect survivorship during poor food years. Subadult males are at greatest risk as 2-year-olds. Young are generally weaned at 2 years and males typically disperse from the maternal home range, often exhibiting long distance movements. Mortality rates increase as rates of movement increase (Knight et al. 1984). Females tend to remain nearer the maternal home range, often continuing to use portions of the original range used as a dependent subadult.

Mean annual survivorship rates of males and females aged 5 through 15 years are similar (89% and 91%, respectively). Six-year-old females exhibited a reduced survivorship, probably a reflection of the mean age at first cub production of 6 years and subsequent increased odds of mortality associated with lack of maternal experience and increased chances for fatal encounters with armed humans while protecting cubs.

Sex and Age Structure

Since 1975 we have radio-instrumented 118 different grizzly bears. An additional four have been trapped, ear-tagged, and released; and 31 cubs and yearlings have been associated with captured females but not tagged. Of these bears, 28 of known age were alive at some time during 1985 (21 instrumented and 7 young of instrumented females). Survivorship rates were applied to 76 bears not observed in 1985 and not believed to be dead (43 radio-instrumented, 4 tagged but not instrumented, and 29 untagged young of instrumented females. These 104 bears were used to construct the age structure illustrated in Fig. 2.

Data from captured and radio-marked bears and their young give an adult sex ratio of .50M:.50F (n = 205) and a subadult ratio of .60M:.40F (n = 174) (Table 8). The adult sex ratio has not significantly varied from 1975 through 1985; however, the subadult sex ratio has gradually shifted from 69% males during the period 1975-79 to 56% males during the period 1980-85. By 1984 the ratio was close to one to one, and 1985 was the only year subadult females outnumbered males in the sample. The proportion of subadults in the samples has gradually increased from less than 50% to approximately 60%. At the same time the proportion of subadult females has increased from less than 40% to over 50%.

The sex ratio for cubs of known litter composition was .55M:.45F (n = 38 cubs in 16 litters). Cub sex ratios are different for the period 1975-79 compared to 1980-85. A sex ratio of .71M:.29F was recorded for the earlier period, and .43M:.57F for the later period. This discrepancy may be due to small sample sizes as only seven and nine litters could be used for the two periods.

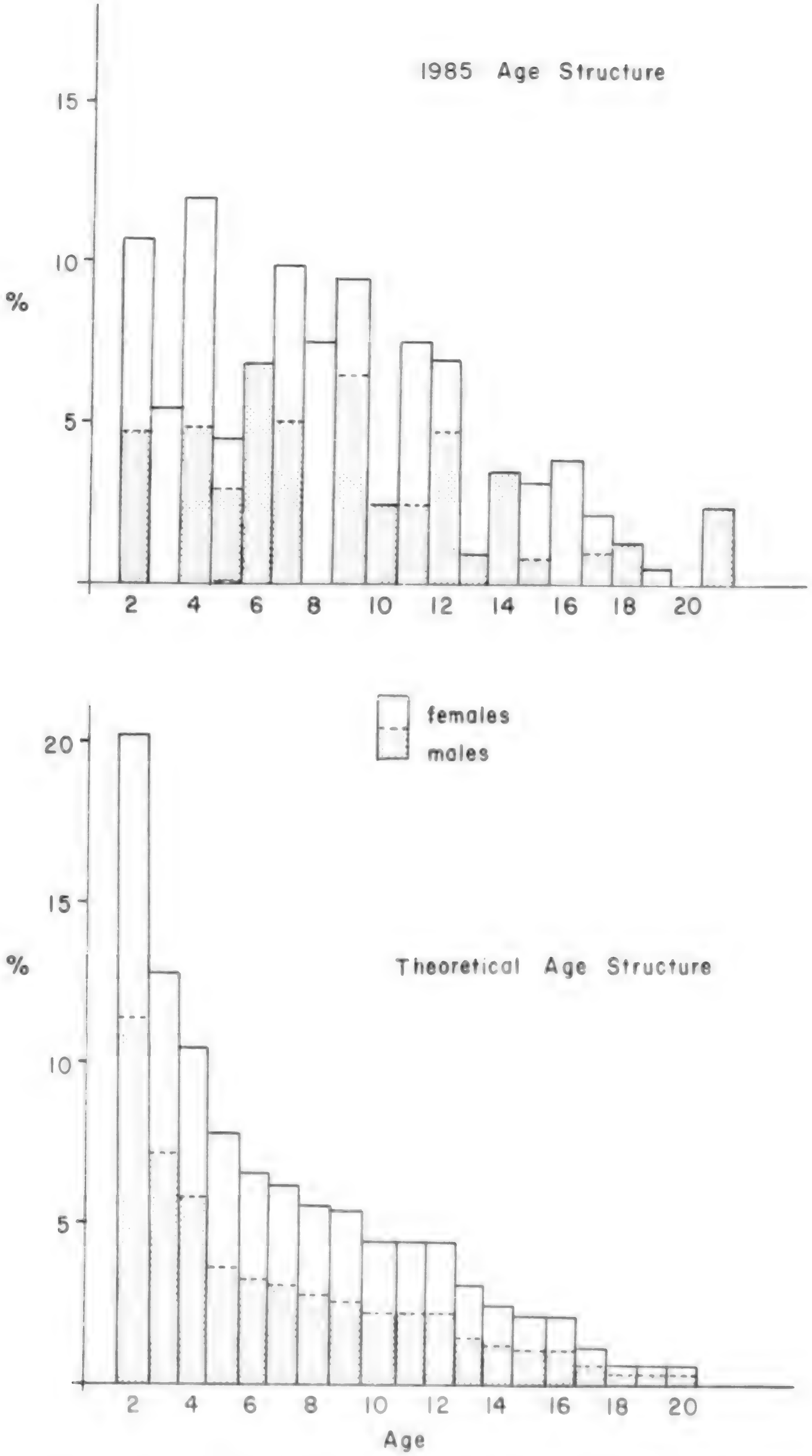

Fig. 2. Comparison of sex and age structure constructed from capture data and theoretical sex and age structure constructed from survivorship rates for 1985.

Table 8. Sex ratios of adult (5+ years) and subadult (cub to 4 years) grizzly bears captured and radio-marked 1975-85. Sample includes unmarked young of captured females.

	Sample size					Sex ratios		
	Adults		Subadults			Adult	Subad.	
Year	M	F	M	F	Unk	M / F	M / F	Ad/Sad
1975	3	3	1	4	-	.50/.50	.20/.80	.55/.45
1976	7	7	4	1	4	.50/.50	.80/.20	.61/.39
1977	9	11	9	5	11	.45/.55	.64/.36	.44/.56
1978	10	10	9	3	7	.50/.50	.75/.25	.51/.49
1979	11	8	11	2	4	.58/.42	.85/.15	.53/.47
1980	14	8	12	7	3	.64/.36	.63/.37	.50/.50
1981	12	14	15	10	5	.46/.54	.60/.40	.46/.54
1982	11	14	19	10	9	.44/.56	.66/.34	.40/.60
1983	11	11	12	8	7	.50/.50	.60/.40	.45/.55
1984	10	9	9	13	7	.53/.47	.41/.59	.40/.60
1985	5	7	3	7	9	.42/.58	.30/.70	.39/.61
1975-79	40	39	34	15	26	.51/.49	.69/.31	.51/.49
1980-85	63	63	70	55	40	.50/.50	.56/.44	.43/.57
TOTAL	103	102	104	70	66	.50/.50	.60/.40	.46/.54

Sex and age structure data from mortalities alone over-estimate the proportion of adult females and subadult males in the population (Fig. 3). Other researchers have demonstrated the inaccuracies of using harvest data alone to construct sex and age structure parameters for bear populations (Harris and Metzgar, in press).

Intra-specific behavioral phenomena may play a part in explaining litter sizes and skewed sex ratios. Selection of markedly more secure but less productive habitat during spring by females with cubs of the year indicates a concern for security - probably not relative to humans but rather relative to other bears. This concern is validated by the occasional appearance of grizzly bear cubs, in grizzly bear scats. Further implicating evidence is found in litter size as a function of female age. Smaller litters typify the first reproductive cycles. This is contrary to a tendency among herbivores for young reproductive-aged females to have larger litters. One strong implication is, therefore, that young reproductive-aged females are less competent mothers. Reduced competence probably results in smaller litters due to mortality, either by malnutrition or predation.

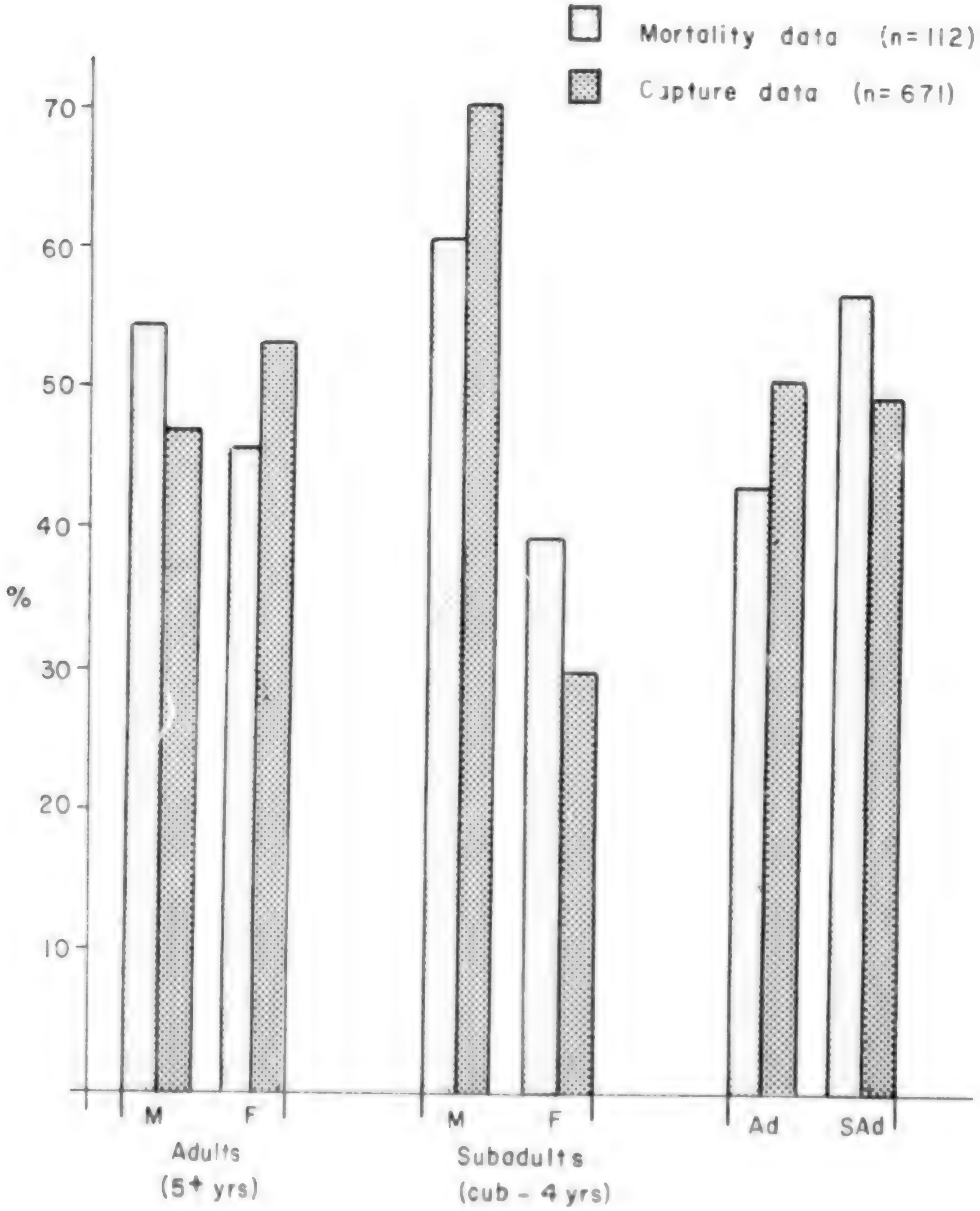

Fig. 3. Comparison of sex and age structures calculated from mortality data and capture data.

Predation by the mother would allow termination of an energy deficit state related to lactation if it develops either because of a poor preceding fall (maternal fat reserves low) or a poor contemporaneous spring (i.e., a food-rich spring could partially compensate for a depauperate preceding fall). Maternally-induced infanticide would not only eliminate the cause of energy drain but also, to a limited extent, recycle expended energy. This "facility" would only characterize carnivorous or omnivorous animals bearing altricial young (Eisenberg 1982).

If this maternal "predation" occurs, then variations in litter size and cub sex ratio could partially be explained. A mother may only kill one of a litter of two or three, thereby reducing a critical marginal energy drain while insuring some immediate degree of reproduction. Infanticide, as is typically the case among humans, may also be sex-specific; female cubs may be killed more often under stressful conditions. This sex-specificity would be logical for several reasons:

(1) Stressful conditions more often accompany a population near carrying capacity. Because females are key to determining population growth, killing females would tend to reduce or limit existing population "pressures" and favor existing individuals.

(2) There is evidence that subadult and young adult females "nest" in their mother's home range versus subadult males, which tend to widely disperse (Knight et al. 1984). If food resources were limited (i.e., precipitating stress for a mother with cubs of the year), then a mother would favor her own longer term survival prospects by killing females of her litter. Males would survive in the immediate future to perhaps propagate her genes, a potential near future competitor for resources would be eliminated (females of the litter), and an immediate energetics crisis would be alleviated.

Mortalities

Categories of grizzly bear mortalities included known, probable, and possible deaths. A mortality involving a retrieved carcass, or parts of a carcass, was a known mortality. Reports of a death by a reliable source (as determined by the Team Leader) with no carcass retrieved were counted as probable mortalities. Persistent and repeated rumors of a death were recorded as possible mortalities. Grizzly bear mortality rates were probably underestimated due to the difficulty involved in obtaining volunteer information concerning illegal deaths of a Federally "protected" species. Mortalities were frequently not reported until several years after the death occurred.

Mortalities from 1973 through 1985 are summarized in Table 9. Eleven known and two probable mortalities were recorded during 1985, including two adult female and two subadult females (Table 10). Seven of the 13 deaths were natural mortalities of cubs and yearlings of unknown sex. Four of these natural

Table 9 . Grizzly bear mortalities, 1973-85.

Year	Known	Probable	Possible	Total (known/ prob.)
1985	11	2	0	13
1984	10	1	0	11
1983	6	0	0	6
1982	17	0	0	17
1981	10	3	3	16
1980	7	3	0	10
1979	3	6	2	11
1978	5	2	3	10
1977	12	4	1	16
1976	5	1	0	6
1975	2	1	0	3
1974	15	0	1	16
1973	13	5	3	21

Table 10. 1985 Grizzly bear mortalities.

Bear	Sex	Age	Location	Date	Cause	Class
No. 120	F	SAd	Granite Cr, BTNF	05-31	Shot by black bear hunter over bait	Known
Unmarked	?	1	Antelope Cr, YNP	May	Natural, young of #59	Known
Unmarked	?	1	Antelope Cr, YNP	May	Natural, young of #59	Known
Unmarked	?	Cub	Fawn Pass, YNP	June	Natural	Probable
Unmarked	?	Cub	Fawn Pass, YNP	June	Natural	Probable
Unmarked	?	1	Sheep Mesa, SNF	Spr.	Natural, young of #106	Known
Unmarked	?	1	Sheep Mesa, SNF	Spr.	Natural, young of #106	Known
Unmarked	F	6-8	Norris, YNP	July	Road kill	Known
No. 67	F	4	Silvergate, MT, GNF	08-05	Mgt. kill (MT)	Known
No. 20	M	12	Watkins Cr, GNF (Deep Well Ranch, MT)	09-24	Mgt. kill (MT)	Known
Unmarked	M	Ad	W of Pilgrim Mtn, BTNF	09-10	Black bear hunter	Known
Unmarked	F	Ad?	Upper Open Cr, BTNF	Aug.	Illegal	Known
Unmarked	?	Cub	S Arm Yellowstone Lk,YNP	Spr.	Natural	Known

Adult female	2
Subadult female	2
Adult male	2
Subadult male	0
Unknown subadults	7
	13

Management control	2
Illegal	3
Natural	7
Road kill	1
	13

mortalities were young of radio-marked females, two were cubs of an unmarked female, and remains of one cub were discovered in a bear scat.

Adult female mortality rates appear to be directly related to annual habitat productivity (Fig. 4, r = -.89). More adult females die during years of low natural food availability. Years of high mortality rates are generally followed by years of lower cub production.

FOOD HABITS

Procedures

Yellowstone grizzly bear food habits were determined from scat analysis and ground investigation of feeding sites. Scats were collected whenever encountered during investigation of aerial and ground radio locations of instrumented bears, and during conduct of other field work. Scats collected during 1985 represented food habits of bears foraging within areas where specific ground investigations were conducted, including areas adjacent to cutthroat spawning streams around Yellowstone Lake, the Antelope Creek/Washburn Range area, and the Firehole River basin.

All bear scats collected (grizzly, black , and species unknown) were included in the analysis. Hair samples were collected from all day beds (n = 100) encountered during 1979. Analysis of the samples (Picton and Knight 1980) revealed 70% were from grizzly bear and 17% were from black bear. The remaining 12% were not from bear. Dried scats were soaked in water to soften them and washed through two screens. Coarse material was retained in the large screen (holes 0.125 in.) and fine material, including seeds, was collected in the small screen (holes 0.0328 in.). All items were identified to species when possible, and the percent volume of each item was visually estimated.

Procedures used in the ground investigation of feeding sites are described by Blanchard (1985). Because feeding activities produce evidence of varying observability and longevity, site examinations were not used alone to determine food habits. Site examinations provide data on habitat use and preference; these examinations also provide data on feeding behavior which produces long lasting sign. Easily digestible food items which are rarely revealed through scat analysis (such as mushrooms) are evident at the feeding site. The more digestible items are probably underrepresented in scat contents and, therefore, in the food habits analysis.

Whitebark pine (Pinus albicaulis) cone production was monitored to determine annual variation in the amount of pine nuts available to bears. Nine 90-m transects were established in whitebark pine stands in the study area during 1980 (Fig. 5). Ten whitebark pine trees were selected along each transect and marked with a blaze and an aluminum identification tag. The

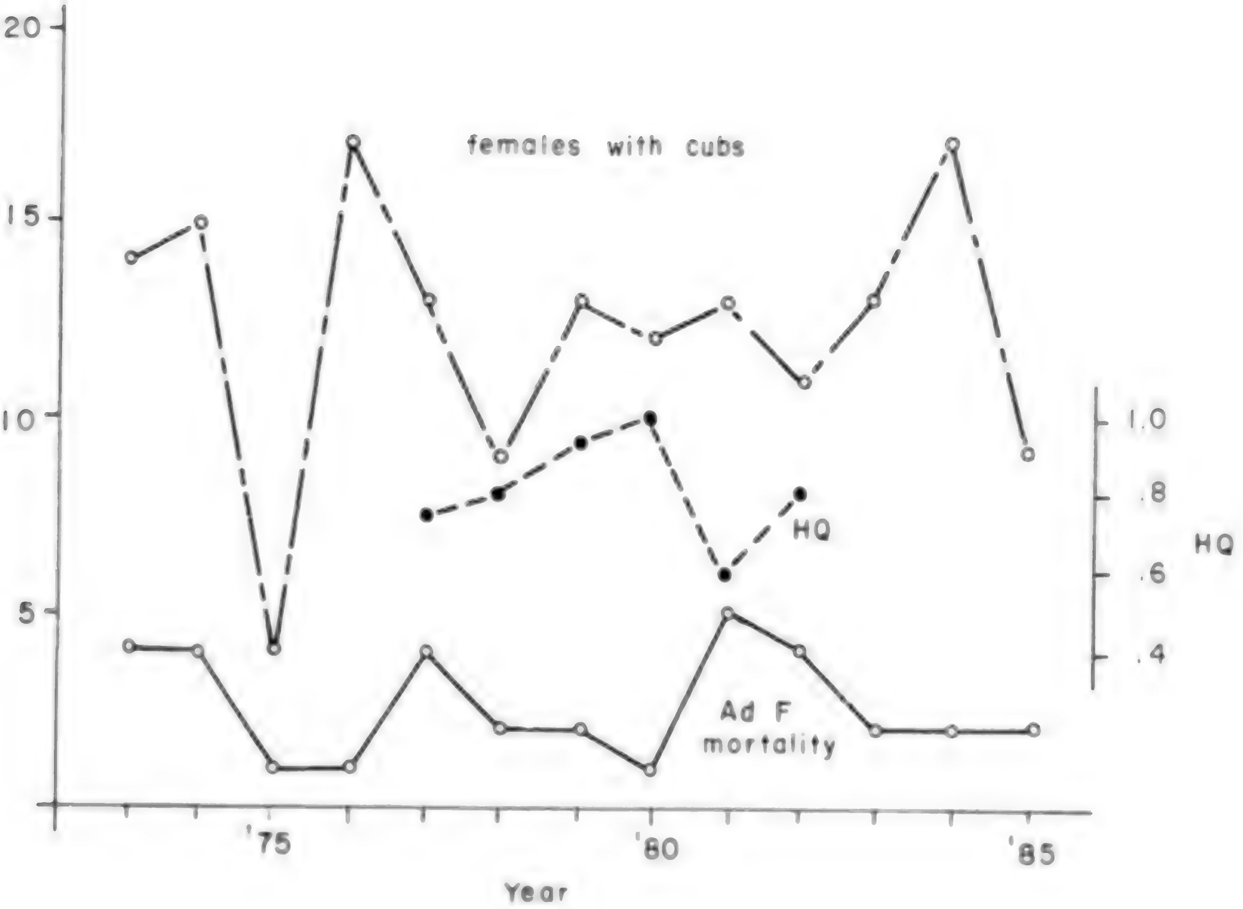

Fig. 4. Annual adult female mortality in relation to habitat productivity and observations of unduplicated females with cubs. Habitat productivity index (HQ) is explained in Knight et al. (in press).

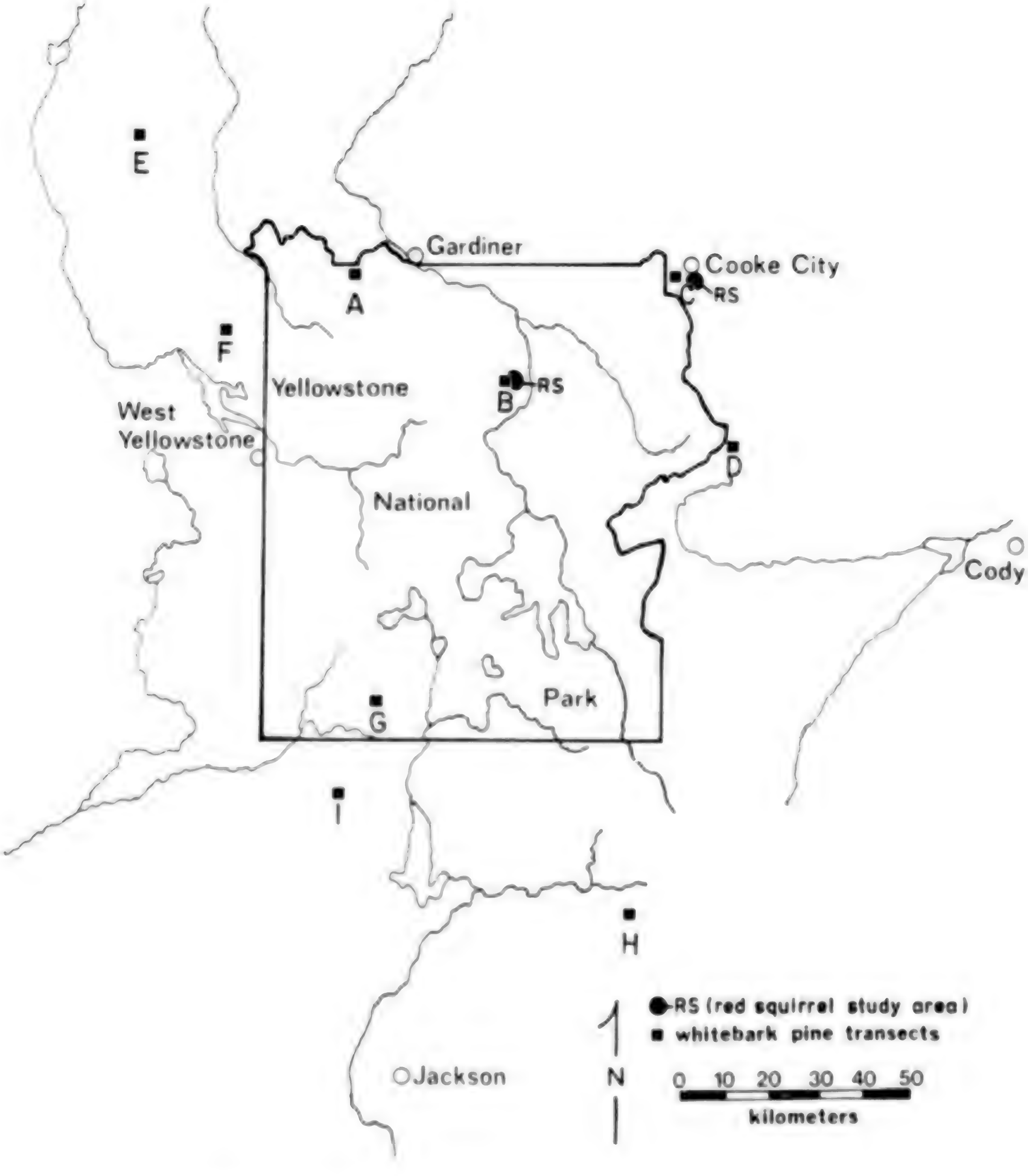

Fig. 3. Locations of whitebark pine cone production transects and red squirrel study subunits.

crown of selected trees could be viewed from the ground from at least two angles. Cones were counted in July and early August when they had reached mature size, but few had been harvested by squirrels. All trunks joined at the base were considered one tree.

Results

Scat analysis.-- Food habits data presented here represent results of faecal analysis. These data often do not accurately reflect relative proportions of ingested diet items primarily because different diet item types are subject to different digestibilities. For this reason, animal matter, berries, and roots are especially underrepresented in scats relative to the vegetal grazing resource. Also, summary data represented in Table 11 represent an agglomeration across all months and seasons. Fall and spring food habits are substantially underrepresented in such a summary. Caution should therefore be used in imputing spring and fall feeding activities from this table. Figure 6 more accurately reflects month-specific trends and food habits.

During 1985, 433 scats were collected and analyzed for content (Table 11), including 26 spring (April-May), 355 summer (June-August), and 52 fall (September-October) scats.

Graminoids were the most frequently (61.5%) observed faecal item during spring and also constituted the greatest scat volume (51.9%) (Table 12). Elk occurred in 66.7% of the scats during April and in only 10% of the May scats. Food items with the highest composition per scat were Microtus sp. (100%), deer (100%), and Vaccinium scoparium leaves (100%).

During summer, graminoids were again observed in faecal matter most frequently (52.4%) and in the greatest volume (30.5%). Forbs were second in frequency and volume, with dandelions most commonly observed in June; thistles and dandelions in July; and thistles in August. Other food items common during summer were cutthroat trout, ants, and whitebark pine nuts. Food items with highest composition per scat were pine nuts (100%), graminoids (100%), cow parsnip(100%), and lomatium tubers (100%).

During fall, whitebark pine nuts dominated the faecal sample, occurring in 76.7% of the September scats and 100% of the October scats. Graminoids and ants were commonly represented in September scats, but by October, pine nuts were the sole food item. Food items with highest composition per scat other than pine nuts were Poa sp. (100%) and lomatium tubers (100%).

Food habits during 1985 reflected availability of whitebark pine nuts and the relatively dry, warm spring and early summer. Vegetation appeared to mature approximately 1 month earlier than average, and grizzly bear use of diet items reflected this. A larger than average proportion of the May diet consisted of

Table 11. Bear scat content analysis, 1985 (n = 433).

Food item	No. scats	% Frequency occurrence	% Diet volume	% Scat composition
Trees				
Pinus albicaulis (pine nuts)	86	19.9	17.3	86.9
Shrubs				
Ribes sp.	1	0.2	0.1	45.0
Vaccinium scoparium	10	2.3	1.9	83.0
Total	11	2.5	2.0	83.0
Sporophytes				
Equisetum sp.	30	6.9	4.2	60.7
Selaginella sp.	1	0.2	0.2	80.0
Total	31	7.2	4.4	61.3
Graminoids				
Bromus sp.	4	0.9	0.2	25.0
Calamagrostis sp.	3	0.7	0.2	26.7
Carex sp.	16	3.7	1.6	43.4
Festuca sp.	1	0.2	0.1	25.0
Poa sp.	18	4.2	1.3	31.4
Grass	1	0.2	0.2	100.0
Grass/sedge	171	39.5	25.1	63.6
Calamagrostis canadensis	1	0.2	0.2	75.0
Bromus anomalus	2	0.5	0.1	15.0
Phleum alpinum	1	0.2	0.1	50.0
Phleum pratense	3	0.7	0.2	28.3
Carex raynoldsii	1	0.2	0.1	20.0
Total	211	48.7	29.3	60.2
Forbs				
Unidentified forb	1	0.2	<0.1	10.0
Agoseris sp.	1	0.2	<0.1	10.0
Angelica sp.	3	0.7	0.2	26.7
Fragaria sp.	2	0.5	0.1	17.5
Lomatium sp.	3	0.7	0.4	60.0
Senecio sp.	1	0.2	<0.1	10.0
Taraxacum sp.	2	0.5	0.1	12.5
Trifolium sp.	15	3.5	0.8	22.3
Umbelliferae/Apiaceae	4	0.9	0.6	61.3
Claytonia lanceolata	4	0.9	0.5	51.3
Epilobium angustifolium	1	0.2	0.1	20.0
Heracleum lanatum	2	0.5	0.4	80.0
Perideridia gairdneri	13	3.0	1.7	57.7
Cirsium scariosum	84	19.4	10.8	55.7
Lomatium cous	14	3.2	1.6	49.6

Table 11. Continued.

Food item	No. scats	% Frequency occurrence	% Diet volume	% Scat composition
Taraxacum officinale	79	18.2	9.3	50.7
Tragopogon dubius	4	0.9	0.9	93.8
Total	169	39.0	27.3	69.9
Mammals				
Unidentified large mammal	4	0.9	0.3	31.3
Elk	19	4.4	2.0	44.5
Bison	5	1.2	0.5	42.0
Microtus	3	0.7	0.4	61.7
Deer	2	0.5	0.4	80.0
Moose	1	0.2	0.1	20.0
Grizzly	2	0.5	0.3	65.0
Inidentified small mammal	1	0.2	<0.1	10.0
Tamiasciurus	1	0.2	0.1	30.0
Total	38	8.8	4.0	45.1
Ants	65	15.0	3.0	19.7
Cutthroat trout	64	14.8	6.2	41.8
Garbage	4	0.9	0.1	8.8
Debris, dirt, wood, etc.	90	20.8	6.6	31.5

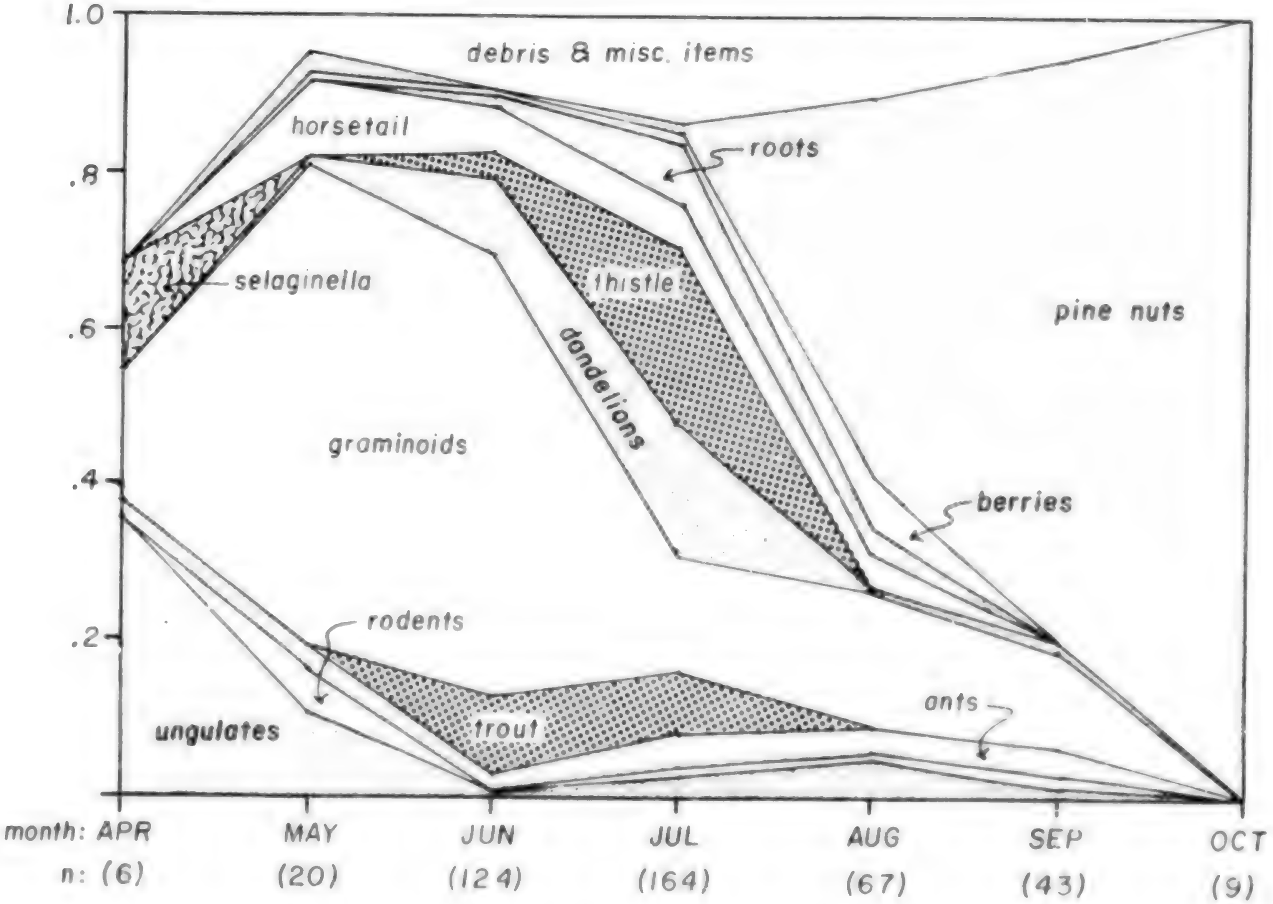

Fig. 6. Volumetric analysis of scats during 1985. Sample sizes are given in parentheses by month.

Table 12. Seasonal scat content analysis for 1985.

	Spring[1]			Summer[2]			Fall[3]		
	n	% freq	% vol.	n	% freq	% vol.	n	% freq	% vol.
Pine nuts	1	3.9	1.5	43	12.1	9.6	42	80.8	77.2
Berries	1	3.9	3.9	10	2.8	2.2			
Grass/sedge	16	61.5	51.9	186	52.4	30.5	9	17.3	10.0
Forbs	1	3.9	0.8	164	46.2	32.6	4	7.7	4.6
Mammals	8	30.8	20.2	27	7.6	3.1	3	5.8	1.6
Insects	7	26.9	2.5	51	14.4	3.1	7	13.5	2.6
Fish				64	18.0	7.5			
Sporophytes	3	11.5	10.4	28	7.9	4.6			
Other	7	26.9	8.9	83	23.4	6.9	4	7.7	3.9

[1] April, May
[2] June, July, August
[3] September, October

foliage, a reflection of faster vegetal growth rates during warmer than normal spring conditions. By August, the diet was dominated by pine nuts, reflecting a better than average nut crop. Exclusivity in use of pine nuts increased steadily until October when pine nuts were the sole item eaten. Use of berries was minimal during summer and fall, reflecting low availability due to lack of moisture and exclusivity of pine nut use. Exclusivity of pine nut use during late summer and fall was also demonstrated by minimal root crop use, and absence of ungulates in the diet. Yellowstone grizzly bears found abundant high fat content pine nuts available during the critical months of August and September, and the majority probably entered dens in optimum condition.

Whitebark pine cone production.--Whitebark pine cone production has been recorded at nine locations throughout the study area from 1980-85 (Table 13). Mean cone production during 1985 was the highest recorded since inception of the transects, with six of the nine transects producing at or above the overall mean of 18.5 cones per tree (Table 14). The least variation among

Table 13. Number of cones in 10 whitebark pine trees at nine locations, 1980-1985.

	Tree											
Transect	1	2	3	4	5	6	7	8	9	10	Mean cones/tree	Avg
A YNP	[a]0	10	47	2	7	4	14	38	25	80	23	22
	[b]12	36	11	1	6	0	24	23	27	138	28	
	[c]11	12	22	4	3	[g]D	1	17	41	30	16	
	[d]7	35	10	22	19	D	23	30	9	32	21	
	[e]4	3	1	0	0	D	1	0	0	5	2	
	[f]37	30	80	15	27	D	15	22	77	75	42	
B YNP	20	25	10	34	35	26	31	6	20	28	24	22
	17	0	2	27	10	16	0	7	8	0	9	
	192	45	10	49	39	14	27	12	20	55	46	
	0	13	10	31	15	26	9	15	16	5	14	
	8	3	9	23	5	11	3	2	9	2	8	
	50	14	6	29	23	44	54	35	22	6	28	
C SNF	7	8	23	6	23	20	0	8	4	40	14	19
	4	0	13	3	5	6	4	11	2	6	5	
	28	6	36	25	6	15	4	11	7	18	16	
	6	10	19	13	30	13	1	16	0	13	12	
	Data not collected for 1984											
	15	25	23	68	123	120	30	42	21	19	49	
D SNF	18	19	19	5	12	6	19	8	6	32	14	23
	12	10	14	6	15	11	5	5	4	7	9	
	10	5	7	17	8	15	17	12	10	34	14	
	10	30	13	12	40	5	3	7	6	29	16	
	Data not collected for 1984											
	39	30	15	50	170	50	35	54	20	162	63	
E GNF	32	26	21	16	28	14	6	18	16	14	19	8
	0	0	0	2	0	0	3	0	3	0	1	
	0	0	0	0	0	0	0	0	0	0	0	
	3	15	5	5	17	29	6	2	3	41	13	
	4	1	4	0	0	0	2	0	15	3	3	
	20	17	5	5	4	11	18	21	27	10	14	
F GNF	25	11	51	50	51	169	20	60	65	60	56	18
	0	0	5	0	0	0	5	3	1	0	1	
	0	0	0	0	0	0	0	0	0	0	0	
	75	10	20	12	7	81	5	0	32	23	27	
	Data not collected for 1984											
	0	0	6	6	0	20	0	0	15	20	7	

Table 13. Continued.

Transect	Tree 1	2	3	4	5	6	7	8	9	10	Mean cones/tree	Avg
G YNP	35	8	50	52	12	90	53	5	28	18	35	12
	3	1	5	50	18	20	22	3	22	0	14	
	1	0	5	28	D	8	3	15	8	0	8	
	1	0	10	38	D	0	33	3	2	0	10	
	0	0	9	6	D	D	6	0	D	0	3	
	0	0	5	6	D	D	5	1	D	D	3	
H SNF	30	25	9	24	30	13	18	28	47	24	25	30
	45	24	18	99	36	50	60	45	100	12	49	
	14	4	38	2	20	17	57	100	110	34	40	
	43	28	27	17	43	71	27	30	79	7	37	
	12	5	10	7	11	10	11	12	38	8	12	
	15	10	14	7	31	17	25	40	26	9	19	
I TNF	42	11	0	18	12	26	14	11	65	16	22	12
	4	1	0	2	0	0	1	5	15	0	3	
	9	2	0	D	8	D	D	25	21	19	12	
	Transect discontinued; J substituted beginning 1983											
J TNF	12	3	6	10	11	1	5	7	10	13	8	10
	12	2	12	11	30	8	6	6	2	8	10	
	13	3	7	16	54	7	8	8	3	5	12	

[a] 1980
[b] 1981
[c] 1982
[d] 1983
[e] 1984
[f] 1985
[g] D = dead

Table 14. Total annual whitebark pine cone production.

Year	n	Mean No. cones/tree	Standard deviation	Coefficient of variation	Range	Total cones
1980	90	25.69	23.87	92.92	0-169	2313
1981	90	13.23	22.85	172.65	0-138	1191
1982	85	16.98	27.63	162.73	0-192	1443
1983	88	17.97	17.61	97.94	0-81	1528
1984	56	6.43	7.28	113.30	0-38	360
1985	85	27.20	32.38	119.06	0-170	2312

transects was recorded during 1980, the second highest producing year of the 6-year period.

Whitebark pine nuts are by far the most important fall food of Yellowstone grizzlies, and availability of the nuts greatly influences their fall movements. High availability during the fall of 1985 was reflected in scat analysis and fall movements. Bears began foraging on nuts during August as red squirrels began harvesting cones, with volume of nuts in scats increasing from 48% during August to 100% by October. No bears were trapped in management actions at lower elevations after August, as virtually all bears were foraging on pine nuts. Bear/human conflicts during fall were all encounters with hunters at high elevations.

In general, years of poor whitebark production result in high mortality rates. Mortality averaged 14 bears (four adult females) during years when pine nut production was poor (1977, 1981, 1982, 1984), compared to an average of 10 mortalities per year (two adult females) during years known to be good nut producing years (1978, 1979, 1980, 1985). From September through November, management actions averaged 12 per year when nut production was low, while no management actions were recorded during years of good nut production (Table 15). Based on these findings, potential intensity of grizzly/human conflicts during late summer and fall can be predicted when nut production is assessed during July.

Table 15. Annual relationship between whitebark pine nut production and numbers of management actions involving grizzly bears.

Year	Whitebark pine nut production (mean cones/tree)	Management actions (trappings)
1977	Poor	5
1978	Great	0
1979	Good	0
1980	26	0
1981	13	21
1982	17	7
1983	18	3
1984	6	14
1985	27	0

GRIZZLY BEAR, RED SQUIRRELS, AND WHITEBARK PINE:

Second Year Progress Report

by

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March 17, 1986

Interagency Grizzly Bear Study Team

INTRODUCTION

Whitebark pine (Pinus albicaulis) nuts are known to be an important diet item of the Yellowstone grizzly bear population. Pine nuts are used primarily in the fall and, to a lesser extent, in late spring and early summer. Kendall (1983) described bear use of pine nuts during the years 1978 and 1979 when whitebark pine nuts comprised nearly all of the Yellowstone grizzly bear diet. Her study followed the highest density annual cone production known for the IGBST study period. Mattson et al. (in press) also documented the major long term contribution of whitebark pine nuts to ingested energy and diet fat of the Yellowstone grizzly bear. Only ungulates were estimated to contribute greater energy and critical structural nutrient elements.

Kendall (1983) also described the important role played by red squirrels (Tamiasciurus hudsonicus) in grizzly bear use of pine nuts. Squirrels harvested and cached otherwise nonabscising cones. Without squirrels present, cones remained essentially unavailable to grizzly bears. Use of pine nuts by bears was thus dependent upon both whitebark pine cone production and population levels and activities of squirrels. The effects of habitat conditions upon red squirrels in the whitebark pine zone has become, then, relevant to management of grizzly bear habitat.

A study was initiated by the IGBST in 1984 and continued in 1985 to investigate the relationships among density and probability of grizzly bear use of squirrel middens, site and stand conditions, and red squirrel activities and population levels. Analysis of study data will enumerate grizzly bear use of specific habitats under different levels of whitebark pine cone production and relate bear use to varying activities and population levels of red squirrels. Study design, methods, and preliminary results and interpretation are reported here.

STUDY AREA

The study area consists of two subunits, one located on the Mt. Washburn massif, the other in the vicinity of Cooke City (Fig. 5). Lower elevational bounds of the study area are at about 2360 m (7800 ft), slightly below the lower elevational limit of whitebark pine distribution. High elevation study area bounds are at the limits of erect tree growth. Both study area subunits are located in higher elevations of the subalpine zone on moderately steep to steep topography.

Most study area timber cover is mature to over-mature; a few stands of pole-sized, even-aged timber occur in the Cooke City subunit. Whitebark pine occurs throughout the study area but is variously represented from dominant to scattered individuals.

The study area consists, in large part, of the Abies lasiocarpa/Vaccinium scoparium-Pinus albicaulis (Abla/Vasc-Pial) and Abies *lasiocarpa*/*Vaccinium globulare*- *V. scoparium* (Abla/Vagl-Vasc) habitat type phases. At lower study area elevations, the *Abies lasiocarpa*/*Vaccinium scoparium*-*V. scoparium* (Abla/Vasc-Vasc) habitat type phase and *Abies lasiocarpa*/*Linnaea borealis* (Abla/Libo) and *Abies lasiocarpa*/*Thalictrum occidentale* (Abla/Thoc) habitat types are relatively common. At higher elevation, on west and south aspects, the *Pinus albicaulis* series prevails.

METHODS

USGS 15' topographic maps and 1:20,000 and 1:30,000 color aerial photography were used to delineate timber stands. Transects were laid out so as to intersect all stands by the following criteria: (1) no transects intersect, and (2) minimum stand edge be encountered or bordered by transects. The second criterion was employed so as to minimize edge effect. Compass bearings were derived for all transects. Transect lengths were determined from air photos and corrected for slope.

Field work began in mid-August and continued through September. Beginning and end points of transects were located by air-photo interpretation and semi-permanently marked. Two people walked each transect; one person was responsible primarily for maintaining transect bearing and pacing, while the other person was responsible primarily for observing squirrel and bear sign.

All stands were identified by habitat type (Steele et al. 1983) and cover type (Mattson and Despain 1985). In addition, between two and eight systematically placed standard forest inventory variable-radius overstory plots were taken in each stand. These data were the basis for analysis stratification and estimation of basal area and average diameter for overstory arboreal species (Fig. 7).

Transects served as the basis for all data collection. Any encountered squirrel or bear sign was referenced to transect locus and estimated perpendicular distance from transect. All feedsites transpired within the contemporaneous calendar year were described by conventional feedsite analysis (Blanchard 1985).

Bear sign data related to use of squirrel middens. All squirrel middens observed from the transect that were determined to have been unequivocally dug up by bears were recorded. Diggings of all ages were noted. Intensity of use by bears was described by a three-part code. Any encountered bear scats were also collected.

Red squirrel data related to sightings, vocalizations, and middens. All instances of unduplicated sightings or vocalizations discerned from the transect and estimated to be within stand bounds were recorded. All middens observed from the transect were also noted. Middens were described as either

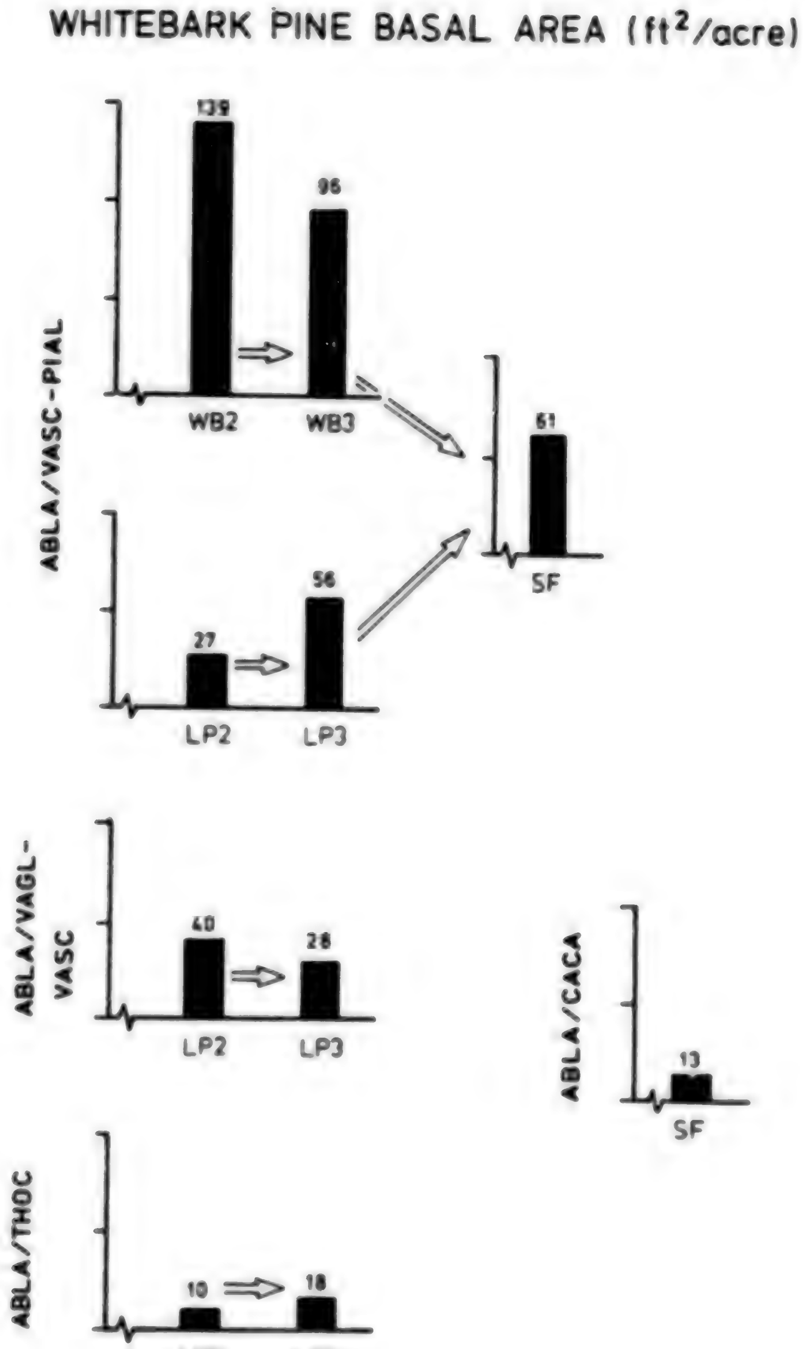

Fig. 7. Mean whitebark pine basal area by cover type and habitat type for the Mt. Washburn study area subunit.

active or inactive, based on presence of cached cones, squirrel(s), or cone clippings of recent age. Midden size was estimated, and abundance and species of cached cones described.

Emphasis in all data collection was placed on maximization of encounter with and replication of different stand types. Thus, measures were taken that returned maximum and, at a minimum, sufficient information for minimum time investment. This approach contrasts with intensive investigation of only a few stands or areas.

PRELIMINARY RESULTS

Data were collected from 134 stands in 1984 and 152 stands in 1985. Fifty of the stands investigated during 1984 and 84 of those investigated during 1985 were located on the Mt. Washburn massif. Whitebark cone production was much greater during 1985 compared to 1984 (1984: Cooke City x = missing, Mt. Washburn x = 8; 1985: Cooke City x = 49, Mt. Washburn x = 28 cones/tree).

Levels of bear use were consistently much higher in the Mt. Washburn subunit compared to the Cooke City subunit. This difference is probably a reflection of lower population density around Cooke City resulting from removal, by management agencies during 1982, of numerous grizzly bears that habitually used the Cooke City dump.

Data from the Mt. Washburn subunit were analyzed in more detail for this report by year, stratified by habitat type, cover type, or aspect and elevation. Substantial differences in bear use and squirrel population and activity parameters were evident by all stratifications.

During 1984, density of active red squirrel middens was highest in the mesic (Abla/Libo, Abla/Thoc, Abla/Vagl-Vasc, and Abla/Vasc-Vasc) habitat types and lowest in the Pial series (Fig. 8). With greater availability of whitebark pine cones during 1985, density of active middens increased substantially in especially the Abla/Vasc-Pial phase and the Abies lasiocarpa/ Calamagrostis canadensis (Abla/Caca) habitat type.

During both 1984 and 1985, density of middens dug up by bears was greatest in the Abla/Vasc and Abla/Caca habitat types. During 1985, density of bear use more strongly peaked in the Abla/Vasc-Pial phase and Abla/Caca habitat type. Density of bear use was lowest in the Pial series, Abla/Thoc habitat type, and Abla/Vagl-Vasc phase.

Preliminary analysis suggests that density of midden use by grizzly bears during 1985 was primarily a function of active midden density and secondarily a function of whitebark pine basal area. When stratified by habitat type, density of midden use by bears was moderately correlated with active midden density ($r = 0.75$, $P = 0.034$). When stratified by cover type, density of

Key:
P = Pial series
AVP = Abla/Vasc-Pial phase
WT = wet habitat types
AW = Abla/Vasc-Vasc phase
AL = Abla/Libo habitat type
AT = Abla/Thoc habitat type
AVgV = Abla/Vagl-Vasc phase

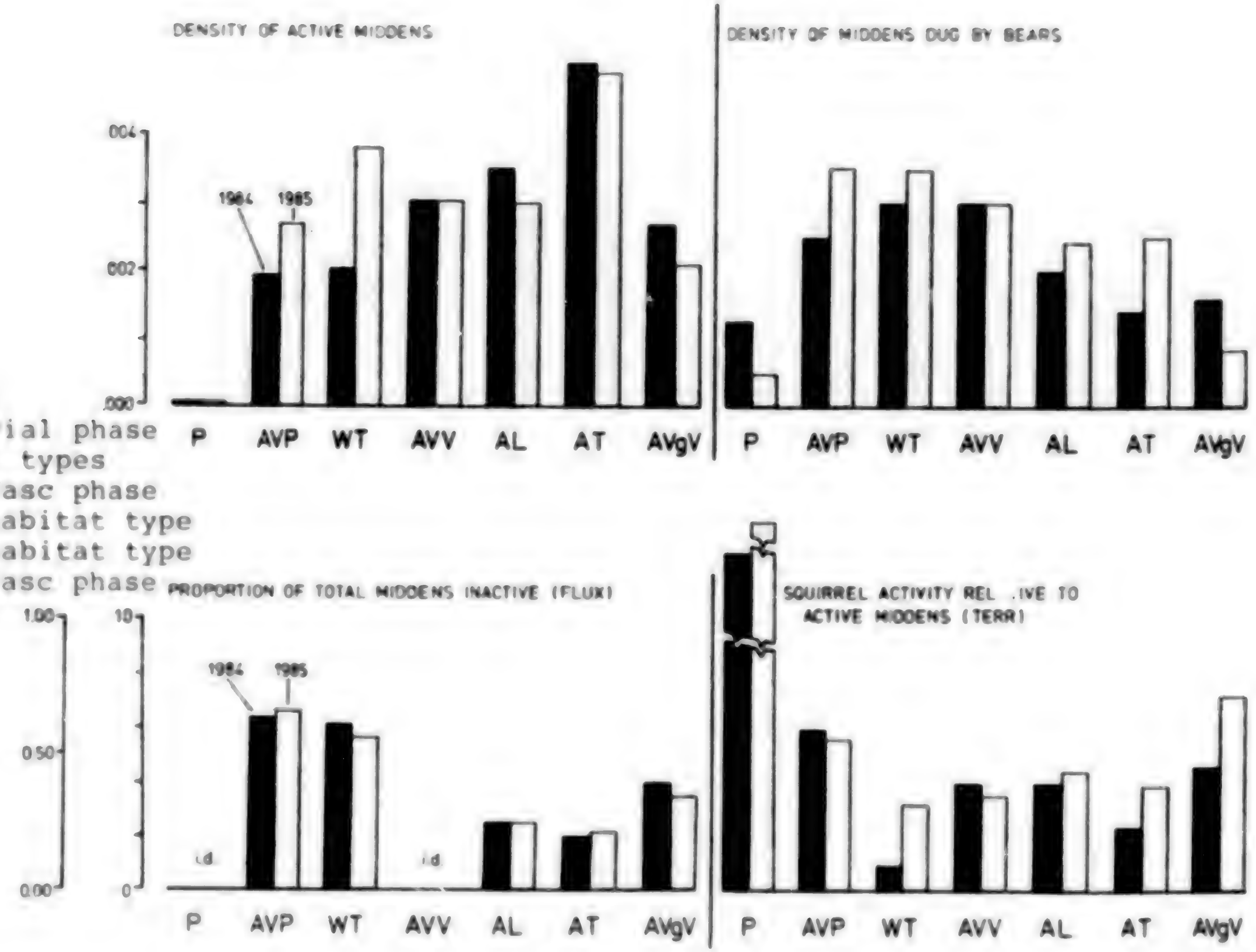

Fig. 8. Density of active middens (MIDD), density of middens dug up by bears (DIG), proportion of total encountered middens that were inactive (FLUX), and squirrel activity relative to density of active middens (TERR) by habitat type for 1984 and 1985 in the Mt. Washburn study area subunit.

midden use was predicted by midden density and whitebark pine basal area ($r = 0.86$, $r^2 = 0.74$, $P = 0.017$; standardized regression coefficients: active midden density = 0.92, whitebark pine basal area = 0.61).

Several derived variables reflected squirrel population dynamics. One such variable (FLUX) was the proportion of all encountered middens considered to be inactive. A high proportion of inactive middens was interpreted to reflect the succession of comparatively high squirrel population levels to low levels. By implication, the squirrel population would be characterized by high year-to-year flux. The Abla/Vasc-Pial phase, Pial series, and Abla/Caca habitat type had, by this measure, high implicated squirrel population flux (Fig 8). This is consonant with the previously mentioned substantial increase in number of active middens in the Abla/Vasc-Pial and Abla/Caca types between 1984 and 1985.

Another variable (TERR) reflected dynamics of territoriality and associated social interaction among squirrels. This variable was calculated by summing the density of vocalizations and sightings attributable to different squirrels and dividing by the number of encountered active middens. We considered number of active middens to be single best indicator of population levels and number of sightings and vocalizations to be as much an indicator of social interaction between squirrels as of population levels. This variable, then, was interpreted to indicate the level of social "instability" or "strife."

The level of sightings and vocalizations, relative to active middens, was highest in the Pial series, and Abla/Vasc-Pial and Abla/Vagl-Vasc phases (Fig. 8). Lower levels characterized especially the Abla/Caca and Abla/Thoc habitat types. High levels in the Pial series and Abla/Vasc-Pial phase fit well the previously mentioned dynamic populations of these types. The Pial series and Abla/Vagl-Vasc phase may also have been subject to yearly varied expansion of territories into these types by squirrels established in adjoining more productive or stable habitat. This would result in greater levels of squirrel interactions without corresponding increase in number of active middens. Both the Pial series and Abla/Vagl-Vasc phase have the lowest levels of bear use and also comparatively low densities of active middens.

We further stratified our analysis of well represented study area habitat types by cover type. In the Abla/Vasc-Pial phase, density of midden use by bears peaked in the late successional subclimax WB3 and LP3 cover types (Fig. 9). Lowest levels of bear use characterized the mid-successional LP2 and WB2 stages. Even though early successional stands were not represented in our sample of the Abla/Vasc-Pial phase, use of earliest successional stages by bears would likely have been minimal.

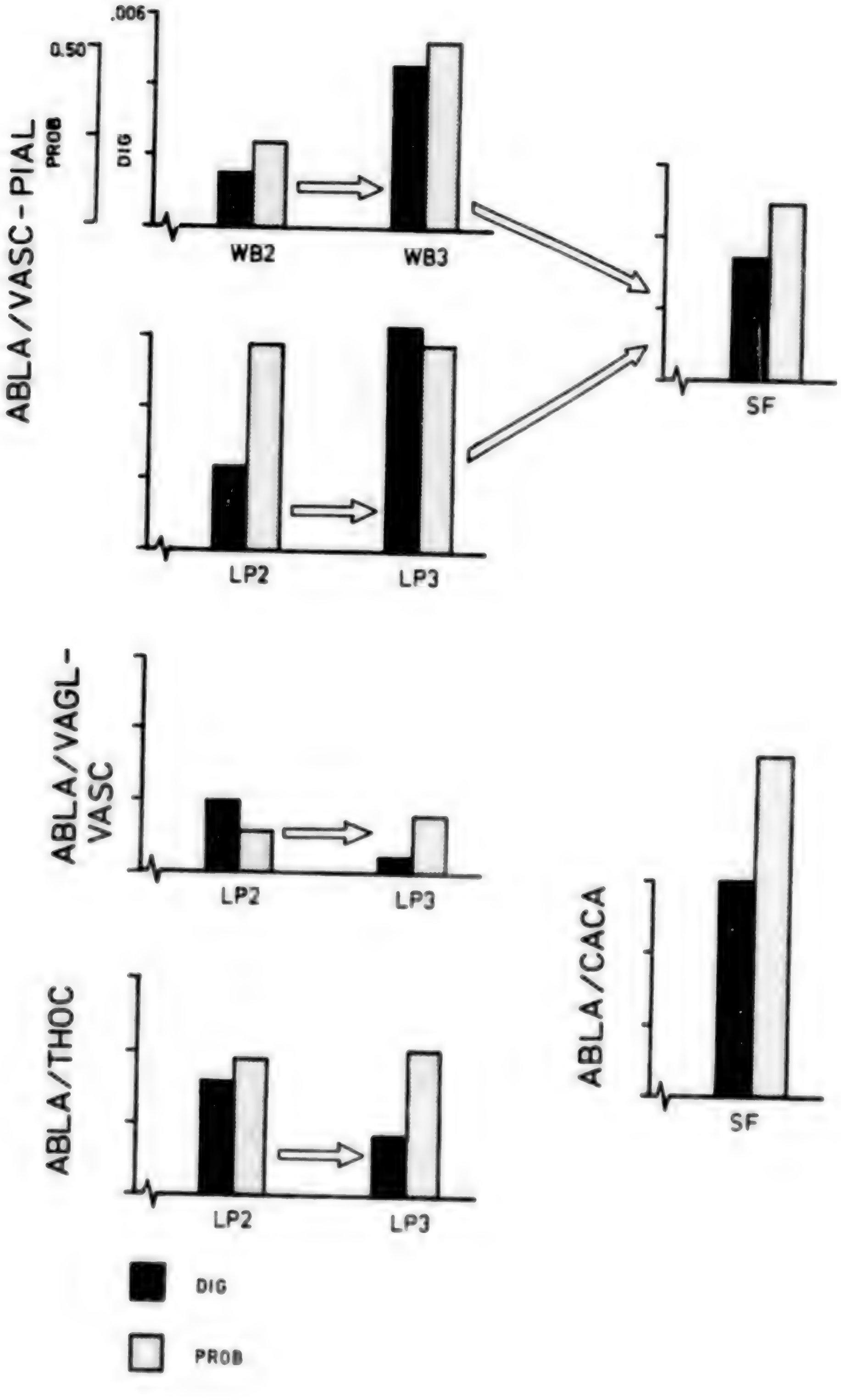

Fig. 9. Density of middens dug up by bears (DIG) and probability of an encountered midden being dug up by a bear (PROB), by cover type and habitat type. Data from 1985, Mt. Washburn.

As noted before, bear use of lower elevation mesic habitat types (the Abla/Vagl-Vasc phase and Abla/Thoc habitat type) was much less than in the Abla/Vasc-Pial phase. Bear use of the mesic types also contrasted with that of the Abla/Vasc-Pial phase by peaking in the mid-successional, LP2, stands and dropping substantially in the late-successional, LP3, stands.

Another derived variable, the probability of an encountered midden having been dug up by a bear, likely reflected preference for individual middens within different habitat and cover types. Highest probability (0.95) characterized spruce-fir (SF) stands of the Abla/Caca habitat type; lowest probabilities (0.12-0.16) characterized the Abla/Vagl-Vasc phase (Fig. 9). Within the Abla/Vasc-Pial phase, highest probabilities of midden use were associated with cover types (LP2 and LP3) containing a substantial admixture of lodgepole pine (Pinus contorta) as well as older growth stands (WB3) characterized by more exclusive representation of whitebark pine.

PRELIMINARY CONCLUSIONS

More indepth interpretation of relationships among grizzly bears, red squirrels, and whitebark pine will need to await further analysis and integration. However, it is apparent by these results that: (1) pure whitebark pine stands are not favorable environments for squirrels and, hence, grizzly bears; (2) mixed species late-successional stands of the Abla/Vasc-Pial phase and Abla/Caca habitat type within the whitebark pine zone are prime late summer and fall habitats for grizzly bear; and (3) habitat management within the whitebark pine zone should emphasize maintenance of late-successional and climax mixed species stands.

Until more information is available concerning the effects of specific silvicultural treatments on red squirrels in the whitebark pine zone, manipulation of forest stands to "enhance" grizzly bear habitat should be conducted with great caution. Also, given the slow growth of arboreal species in the whitebark pine zone and concurrence of highest density bear use with late-successional or climax stands, harvest of existing stands followed by planting of whitebark pine does not appear to be a particularly beneficial management practice. In any case, access necessarily attending any silvicultural practices of itself poses risks to grizzly bears. Very likely these displacement and mortality risks far outweigh any gains possible by overt forest manipulation.

Ideally, a study of this nature should last a minimum of 10 years because of the considerable known variation in small mammal populations. We plan to continue this study for at least 3 more years. This would allow us to track the fate of squirrel populations as well as the nature of bear use in specific habitats following the availability of abundant whitebark pine cones in the fall of 1985. Conceivably, the Pial series could become an ephemerally valuable type during the spring and summer following a fall of abundant cone production such as during 1985.

YELLOWSTONE LAKE TRIBUTARY STUDY

1985 Progress Report

by D. Reinhart and D. Mattson

INTRODUCTION

Brown bears (Ursus arctos) are known to prey upon spawning salmonids in Alaska (Clark 1957, Glenn and Miller 1980) and southeastern Soviet Union (Bromlei 1965). Hoskins (1974, 1975) and Mealey (1975) have shown that Yellowstone grizzlies use spawning cutthroat trout (Salmo clarkii) in tributary streams of Yellowstone Lake. Mealey (1975) suggested that spawning trout are a focal diet item in the grizzly bear foraging economy centered on Yellowstone Lake. This use of spawning fish by bears in both Alaska and Yellowstone Park is consonant with the fact that grizzlies are basically carnivores and are well able to digest proteinaceous foods such as fish (Herrero 1978, Bunnell and Hamilton 1980).

Since 1975, more information concerning Yellowstone grizzlies has become available; changes in the Yellowstone Lake cutthroat trout population have also occurred. Knight and Eberhardt (1984, 1985) suggested that the Yellowstone grizzly population was in such a precarious state that loss of an additional female per year could lead to eventual extinction. Gresswell (1980), Varley (1983), and Jones et al. (1983) have also shown that the Yellowstone Lake cutthroat trout population increased in the last 10 years and was comprised of larger and older fish.

These two factors suggest the need for more information about use of potentially valuable trout by bears and the changes in use patterns since Hoskins' 1974 and 1975 studies. Yellowstone Lake spawning streams are well within the bounds of Yellowstone Park and could potentially serve as attractants keeping bears away from more hazardous environments on the park's periphery.

A study was initiated during 1985 to collect data on use of spawning cutthroat trout by grizzly bear in Yellowstone Park. From these data we hope to address questions and concerns which have arisen concerning grizzly bear and cutthroat trout in the last 10 years. Overall objectives of the study were as follows:

1. To appraise the relative value of spawning cutthroat trout as a food source for Yellowstone grizzly bears.

2. To quantify spawning stream attributes that contribute to usability by grizzly bears.

3. To identify any changes in use patterns since Hoskins' study of 1974-75.

A report of this study's first year methods, preliminary results, and recommendations is presented here.

STUDY AREA

The 1985 study area was comprised of backcountry streams tributary to Yellowstone Lake. This included streams along the east shore from Sedge Bay to the Southeast Arm, the South Arm, Flat Mountain Arm, and the west shore to Grant Village. The streams along the West Thumb and the north shore were not studied because of limited resources and time.

METHODS

Field work was conducted from May 29 to August 6, 1985. The study team consisted of two members of the Interagency Grizzly Bear Study Team (IGBST) and two members of the U.S. Fish and Wildlife Service (USFWS). The USFWS provided most of the necessary equipment and supplies for the study. This included two 14-ft aluminum boats with 25- and 35-hp outboard motors.

All tributary streams in the study area were examined sequentially by boat until it was known they would not support a spawning run, or the spawning run cycle was complete. Streams supporting spawning runs were systematically surveyed; 100- or 200-m sections were marked along the streams. Irregular section lengths were occasionally marked to accommodate prominent changes in stream characteristics.

The following data were collected by the IGBST field crew for each section of stream on every visit:

1. Water temperatures were taken using a mercury thermometer. Time of day was also recorded.

2. Depths and widths were periodically taken using an increment stick measured in tenths of a meter. Mean and maximum were recorded.

3. Stream substrate was visually identified and classified as silt, sand, gravel, cobble, boulders, or bedrock.

4. Stream gradient was measured as percent slope using a Sunto clinometer.

5. Meanders and pools were counted on the first visit to each stream.

6. Vegetation was classified by habitat type (Mattson 1984, Steele et al. 1983) and cover type (Mattson and Despain 1985).

7. Distance to cover from streamside was estimated in meters.

8. Fish density was visually estimated using two methods: (1) fish were counted using a tally counter while walking upstream; and (2) a relative fish density was estimated using the following terms: abundant, numerous, common, present, and none-rare (Hoskins 1974).

9. Bear activity was recorded by four measures: (1) scats along the stream were counted and collected for analysis; (2) fish parts were counted and tossed into the stream to avoid recounting; (3) tracks were counted, measured, and marked to determine the number of bears using the stream; and (4) bear trail use along the stream was classified as none, light, moderate, heavy, and very heavy.

Additional data were provided by the USFWS for each stream examined:

1. Fish density estimates were made on 100-m sections of the smaller streams using a Coffelt backpack electro-shocker. Lengths, sex, and stage of maturity of spawning trout were recorded.

2. Flow measurements were taken using a Curley Pigmey flow meter.

3. Depths and widths were measured on the 100-m shocking sections using a measuring tape and wading rod.

4. Substrate composition was visually classified as fines, gravel, cobble, boulders, or any two combinations of these.

5. Physical structures judged usable as cover by spawners were classified as undercut banks, pools, deadfall, and overhanging vegetation.

Another two-man crew from the USFWS spent a portion of the summer examining tributary streams not in the study area, including streams along the West Thumb north from Grant Village, and along the north shore of Yellowstone Lake.

RESULTS

Collected data have not yet been fully analyzed. A few results, however, can be reported. A total of 73 streams in the study area were visited between one and eight times with a mean of 3.5 visits. Of these streams, 35 were found to have a spawning run and were examined a mean of 4.8 times (Table 16, Fig. 10), and 22 streams showed evidence of bear activity and were examined a mean of 5.3 times (Table 17, Fig. 11). Bear sign on these latter streams was found in the form of scats, tracks, fish parts, trails along the stream, evidence of grazing, and observations. Nine streams had conclusive evidence of bear fishing and were examined a mean of 6.6 times (Table 18, Fig 12); fish parts or scats containing fish parts were found along these streams.

Table 16. Study area streams with spawning runs.

Stream sonyew No.	Name or Hoskins No.	No. visits in 1985	1974-75 findings	1985 findings
0098	2	8	Yes	Yes
0100	Cub Cr	8	Yes	Yes
0103	6	5	Yes	Yes
0104	Clear Cr	7	Yes	Yes
0113	Meadow Cr	4	Yes	Yes
0115	Columbine Cr	7	Yes	Yes
0119	53	2	Yes	No
0121	55	6	No	Yes
0124	58	3	Yes	No
0125	Beaverdam Cr	3	Yes	Yes
0129	Trail Cr	3	Yes	Yes
0131	59	5	Yes	Yes
0134	62	5	Yes	No
0136	64	6	Yes	Yes
0138	65	5	Yes	Yes
0141	66	2	No	Yes
0142	67	2	No	Yes
0145	68	2	No	Yes
0153	Chipmunk Cr	4	No	Yes
0160	73	3	No	Yes
0161	74	6	No	Yes
0165	Grouse Cr	4	Yes	Yes
0168	76	7	Yes	Yes
0169	77	5	Yes	Yes
0173	81	4	Yes	Yes
0174	82	4	Yes	Yes
0176	84	4	Yes	Yes
0179	87	4	Yes	No
0180	88	6	Yes	Yes
0181	89	2	Yes	No
0186	92	4	Yes	Yes
0188	94	4	Yes	Yes
0189	96	6	Yes	Yes
0191	97	6	Yes	Yes
0192	98	6	Yes	No
0193	99	5	Yes	No
0195	101	5	Yes	Yes
0196	102	2	Yes	No
0200	106	[illegible]	Yes	Yes
0202	107	1	Yes	Yes
0203	108	3	Yes	Yes
0205	109	2	No	Yes
0211	41	1	Yes	No
0212	Solution Cr	3	Yes	Yes

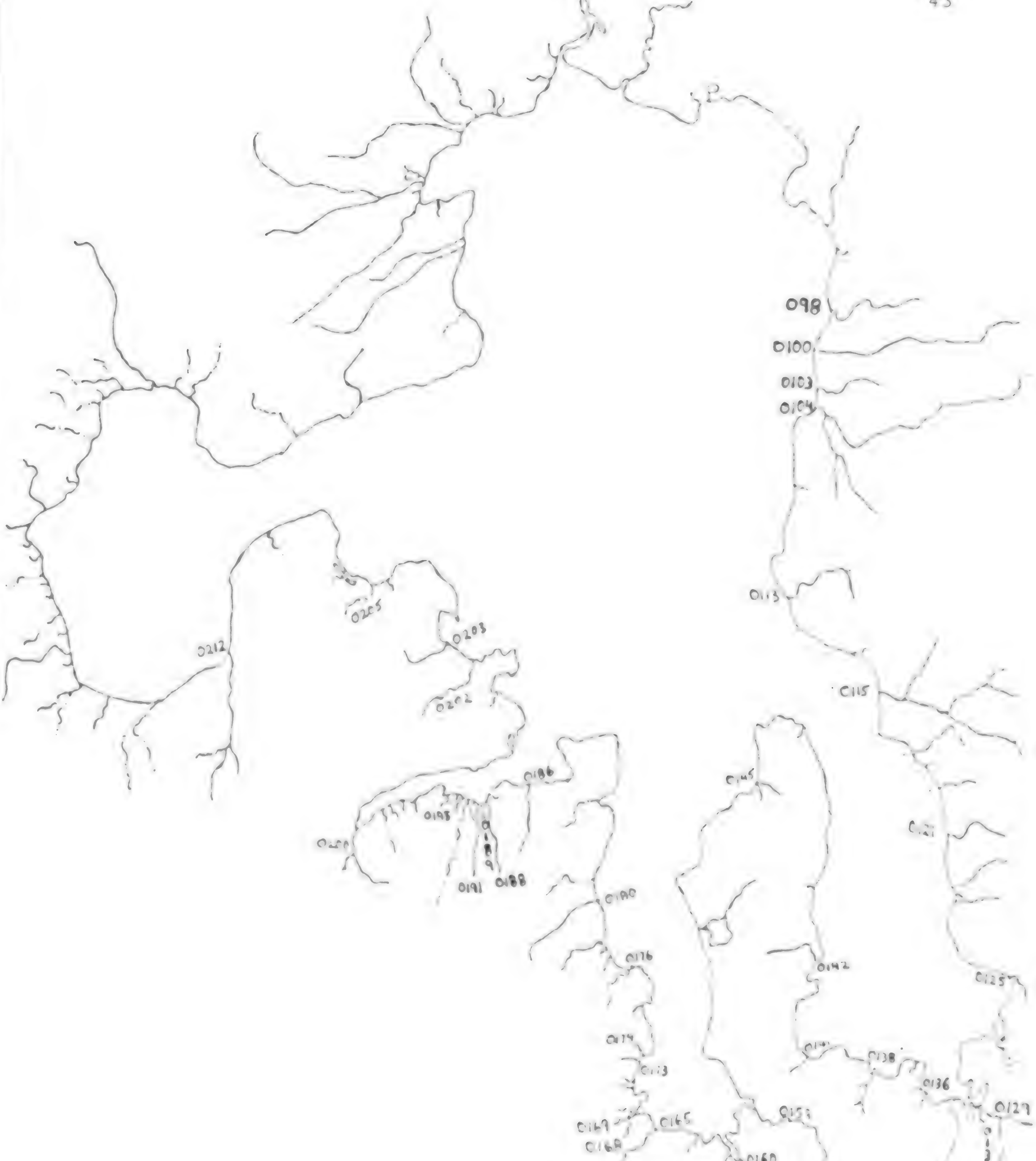

Fig. 10. Study area streams with spawning zone in 1985.

Table 17. Study area streams with bear activity.

Stream sonyew No.	Name or Hoskins No.	No. visits in 1985	1974-75 findings	1985 findings
0098	2	8	No	Yes
0100	Cub Cr	8	No	Yes
0104	Clear Cr	7	No	Yes
0115	Columbine Cr	7	No	Yes
0136	64	6	Yes	Yes
0138	65	5	Yes	Yes
0141	66	2	No	Yes
0145	68	4	No	Yes
0160	73	3	No	Yes
0161	74	6	No	Yes
0165	Grouse Cr	4	No	Yes
0168	76	7	Yes	Yes
0169	77	5	Yes	Yes
0176	84	4	Yes	Yes
0179	87	4	Yes	No
0180	88	6	Yes	Yes
0186	92	4	No	Yes
0188	94	7	Yes	Yes
0189	96	6	No	Yes
0191	97	6	Yes	Yes
0193	99	5	Yes	Yes
0195	101	5	Yes	Yes
0200	106	7	Yes	Yes
0202	107	3	Yes	No
0203	108	3	Yes	Yes
0212	Solution Cr	3	No	Yes

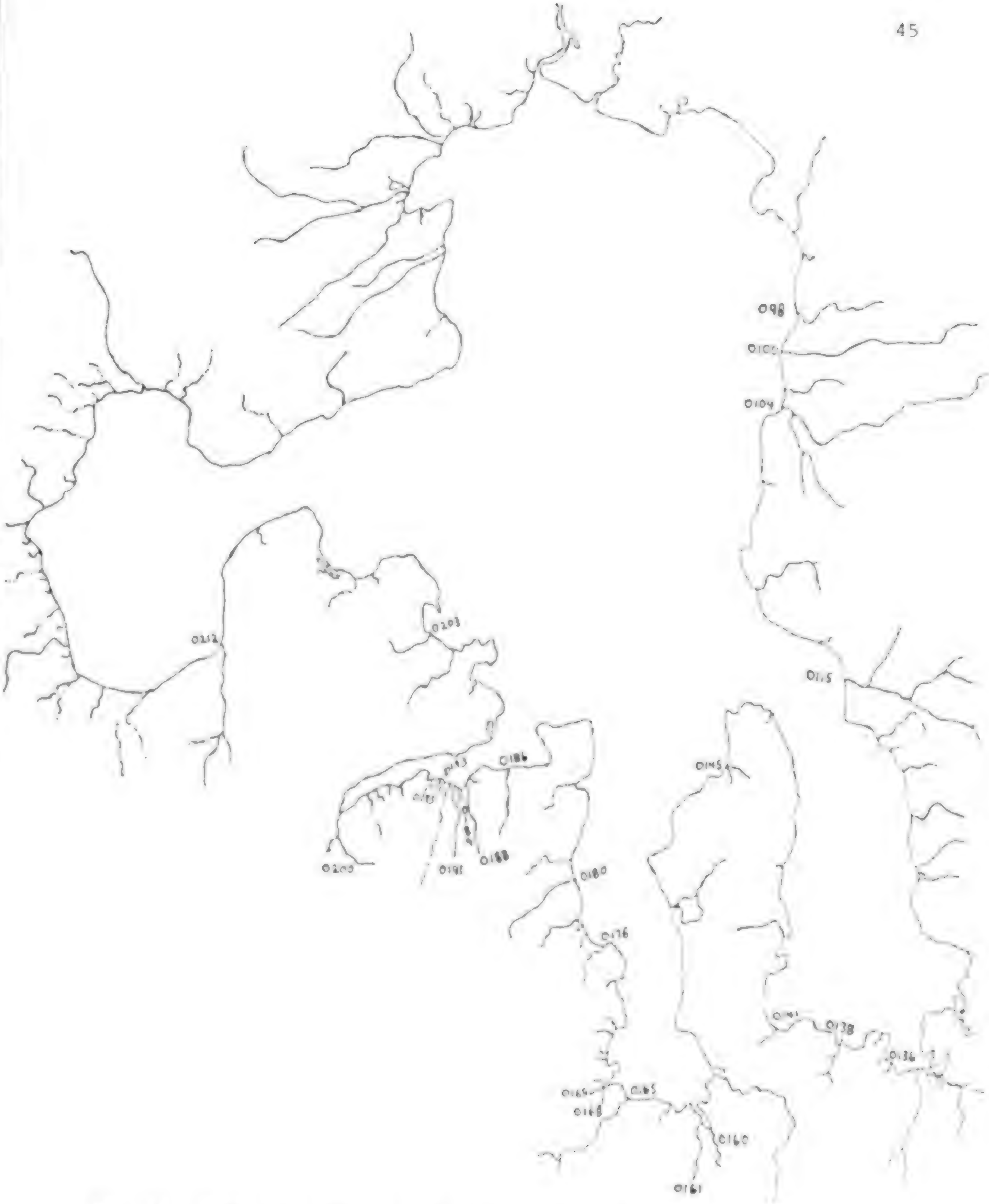

Fig. 11. Study area streams with bear activity in 1985.

Table 18. Study area streams with bear fishing activity.

Stream sonyew No.	Name or Hoskins No.	No. visits in 1985	1974-75 findings	1985 findings
0098	2	8	No	Yes
0100	Cub Cr	8	No	Yes
0104	Clear Cr	7	No	Yes
0136	64	6	Yes	No
0138	65	5	Yes	No
0161	74	6	No	Yes
0168	76	7	Yes	Yes
0180	88	6	Yes	Yes
0191	97	6	Yes	Yes
0195	101	5	Yes	Yes
0200	106	7	Yes	Yes

Table 19. Streams not in study area with bear fishing activity.

Stream sonyew No.	Name or Hoskins No.	No. visits in 1985	1974-75 findings	1985 findings
0214	Sewer Cr	1	Yes	Yes
0228	Little Thumb Cr	1	Yes	Yes
0229	32	1	Yes	Yes

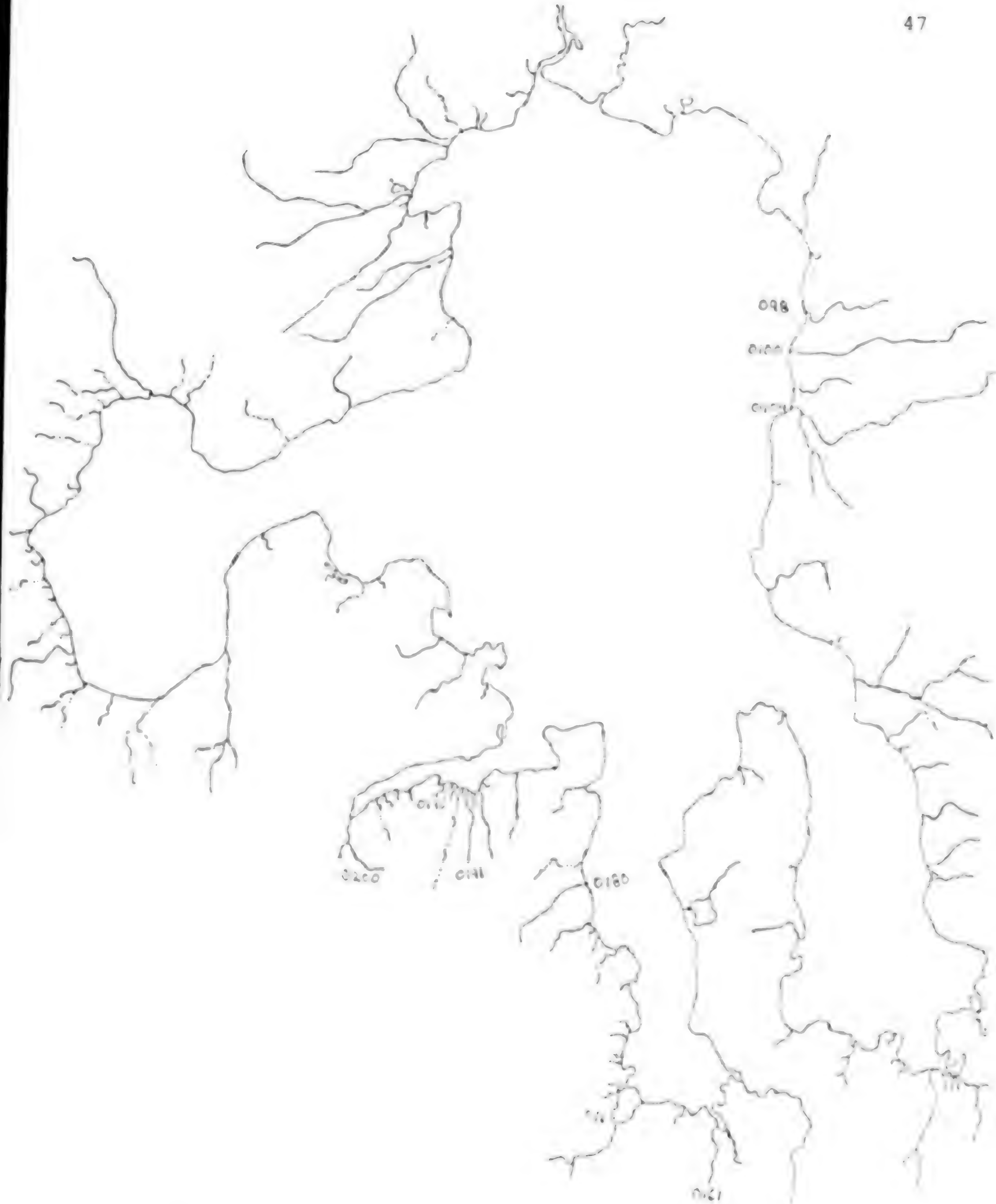

Fig. 12. Study area streams with bear fishing activity in 1985.

Of the nine streams supporting bear fishing activity, five were known to be fished by bears in 1974 or 1975 (Hoskins 1975). Streams 0098, 0100 (Cub Creek), 0104 (Clear Creek), and 0161 were fished by bears in 1985 but not in 1974-75 (Table 18). Streams 0136 and 0138 were fished by bears in 1974-75 (Hoskins 1975) but not in 1985. These latter streams, however, had considerable associated bear sign when examined in 1985. Streams 0214 (Sewer Creek), 0228 (Little Thumb Creek), and 0229 were fished by bears in 1974-75 but were not included in our 1985 study area. Bear use of these streams in 1985 was confirmed by a reconnaissance survey. Hoskins (1975) also noted bear fishing for longnose suckers (*Catostomus catostomus*) in Pelican Creek during 1974. Our 1985 reconnaissance did not include Pelican Creek.

DISCUSSION

Hoskins (1975) suggested that availability of trout to bears was dependent on two factors: trout density in the stream, and stream physical characteristics. Most of the streams fished by bears were smaller; fish could be easily trapped against the bank and caught (Hoskins 1975, Mealey 1975). Exceptions were Cub Creek (0100) and Clear Creek (0104) where fishing success appeared to be primarily in shallow riffles. Larger streams with little or no shallow riffles showed no evidence of bear fishing.

We speculate that "fishability" or value of a spawning stream is also derived in part from its juxtaposition relative to other streams. Spawning streams supporting bear fishing were usually clustered. An example of this is along the south shore of Flat Mountain Arm. Although most of these streams did not have sizable spawning runs and bears were known to fish only two streams, significant amounts of sign were found along all of the watercourses in this area. Other examples of close proximity spawning streams utilized heavily by bears are those on the southern portions of the South and Southeast Arms and those along the east shore (Fig. 11).

Year-to-year consistency of spawning runs may also be a key factor in bear fishing use of streams. Of the 10 streams fished by bears in 1974-75 (Hoskins 1975) eight were found to be fished by bears in 1985. This consistency of bear use suggests an affinity for certain spawning streams possibly linked to consistency of the spawning run.

Less than half the spawning streams at which bear sign was found had evidence of bear fishing. This suggests that either (1) bear fishing sign was not always found by the study team, (2) bears may not be very successful in fishing certain streams, or (3) bears may be attracted to streams for more reasons than the presence of spawning cutthroat trout. Mealey (1975) found through scat analysis that cutthroat trout and grasses were of near equal importance to grizzly bear in the lake economy. Most streams with bear sign were adjoined by open meadows with an abundance of wetland grasses, sedges, and forbs. Bear grazing along streams was noted consistently by the IGBST and may also be a key reason why bears visit spawning streams and associated habitat.

RECOMMENDATIONS

There has been considerable research on Yellowstone Lake's cutthroat trout (Cope 1964). However, most of the research concerned with spawning cutthroat trout has focused on only a few tributary streams (Cope 1957, Ball and Cope 1961, Benson and Bulkley 1963). With the exception of Hoskins' study (1974, 1975), no research has encompassed all the spawning streams tributary to Yellowstone Lake.

We recommend that a full systematic analysis of Yellowstone Lake's spawning streams be continued. This study should be conducted as a joint effort of the IGBST and USFWS. During 1985 this proved to be an excellent collaboration that provided important data for both agencies. Information gained from this study is of value to management of the cutthroat trout population for sports fisheries as well as for food of the Yellowstone grizzly bear.

To gain a better understanding of the value of spawning cutthroat trout and their host streams to the Yellowstone grizzly bear, the following recommendations are made:

1. Study spawning runs and bear use over a period of 2 to 3 years to gather more data on year-to-year variability in spawning run density, stream conditions, and related bear use.

2. Increase the study area to encompass all of the streams tributary to Yellowstone Lake. This would include streams in the crucial Grant Village-West Thumb area as well as on the north shore of Yellowstone Lake.

3. Examine more thoroughly the larger tributary streams of Yellowstone Lake. Due to time limits these streams were examined upstream only 1 to 2 km. Surveys showed the spawning runs extended further upstream. The study area should examine the upper reaches of these larger tributaries for spawning runs and bear use. The USFWS should sample these streams for fish density. Equipment larger than the backpack electro-shocker would be required.

4. Acquire a better understanding of the relationship between water temperatures and cutthroat trout spawning runs. Temperatures taken during 1985 were not very useful. Max-min thermometers deployed in spawning streams known to be fished by bears would provide more useful information. Thermographs placed in a few important streams would be most desirable.

5. Conduct a more thorough vegetation analysis of the stream sides where bear sign is found. This can be accomplished through scat analysis as well as habitat surveys.

6. Examine bear tracks along streams in more detail so that tracks of individual bears can be identified. This could provide information on grizzly bear versus black bear use, individual bear use of other streams, and an estimate of bear numbers using Yellowstone Lake's tributary streams.

7. Field work should begin as early as May 1 so as to allow data collection on spawning runs in streams along the West Thumb and west shore. These streams, when checked in late May 1985, were at the middle or end of their spawning cycle.

LITERATURE CITED

Ball, O. P., and O. B. Cope. 1961. Mortality studies on cutthroat trout in Yellowstone Lake. U.S. Fish & Wildl. Serv. Res. Rep. 55:1-62.

Benson, N. G., and R. V. Bulkley. 1963. Equilibrium yield and management of cutthroat trout in Yellowstone Lake. U.S. Fish & Wildl. Serv. Res. Rep. 62:1-38.

Blanchard, B. 1985. Field techniques used in the study of grizzly bears. USDI, Nat. Park Serv. 24pp.

Blanchard, B. (In press) Size and growth patterns of the Yellowstone grizzly. Presented at the 7th Int. Conf. on Bear Res. and Manage., Williamsburg, VA, Feb. 19-26, 1986.

Bromlei, F. G. 1965. Bears of the south far-eastern USSR. 1973 publ. by Indian Natl. Sci. Doc. Centre and U.S. Dep. Comm. 138pp.

Bunnell, F. L., and T. Hamilton. 1980. Forage digestibility and fitness in grizzly bears. Pp. 179-185 in C. J. Martinka and K. L. McArthur, eds. Bears - their biology and management. Papers of the 4th Int. Conf. on Bear Res. and Manage. Bear Biol. Assoc. Conf. Ser. 3.

Clark, W. K. 1957. Seasonal food habits of the Kodiak bear. Trans. of the North Am. Wildl. Conf. 22:145-151.

Cope, O. B. 1957. The choice of spawning sites by cutthroat trout. Proc. Utah Acad. Sci. Arts and Letters 34:73-79.

_____. 1964. Revised bibliography on the cutthroat trout. U.S. Fish and Wildl. Serv. Res. Rep. 65.

Craighead, J., J. Varney, and F. Craighead. 1974. A population analysis of the Yellowstone grizzly bears. Montana For. and Conserv. Exp. Sta. Bull. 40. Univ. of Montana, Missoula. 20pp.

Eberhardt, L., R. Knight, and B. Blanchard (In press) Monitoring grizzly bear trends. J. Wildl. Manage.

Eisenberg, J. F. 1982. The mammalian radiations. Univ. of Chicago Press, Chicago. 509pp.

Glenn, L. P., and L. H. Miller. 1980. Seasonal movements of an Alaska Peninsula brown bear population. Pages 307-312 in C. J. Martinka and K. L. McArthur, eds. Bears - their biology and management. Bear Biol. Assoc. Conf. Ser. 3.

Gresswell, R. E. 1980. Yellowstone Lake - a lesson in fishery management. Pages 143-148 in W. King, F. Richardson, J. Peters, and M. Reidel, eds. Proc. of Wild Trout II - Yellowstone Nat. Park. Joint Publication of Trout Unlimited, Federation of Fly Fishermen. U.S. Dep. Interior. Sep. 1979. Washington, D.C.

Harris, R., and L. Metzgar. (In press) Harvest age-structures as indicators of decline in small populations of grizzly bears. Presented at the 7th Int. Conf. on Bear Res. and Manage., Williamsburg, VA, Feb 19-26, 1986.

Herrero, S. 1978. A comparison of some features of the evolution, ecology, and behavior of black and grizzly/brown bears. Carnivore 1(1):7-17.

Hoskins, W. P. 1974. Yellowstone Lake tributary survey project. Interagency Grizzly Bear Study Team. Unpubl. report. 10pp.

_____. 1975. Yellowstone Lake tributary study. Interagency Grizzly Bear Study Team. Unpubl. report. 31pp.

Jones, R. D., P. E. Bigelow, R. E. Gresswell, L. D. Lentsch, and R. A. Valdez. 1983. Annual project technical report - 1982. Fishery and aquatic management program - Yellowstone National Park. U.S. Fish and Wildl. Serv. Unpubl. mimeo.

Kendall, K. C. 1983. Use of pine nuts by grizzly and black bears in the Yellowstone area. Int. Conf. Bear Res. and Manage 5:166-173.

Knight, R., and L. Eberhardt. 1984. Projected future abundance of the Yellowstone grizzly bear. J. Wildl. Manage. 48(4):1434-1438.

_____, and _____. 1985. Population dynamics of Yellowstone grizzly bears. Ecol. 66(2):323-334.

Knight, R., D. Mattson, and B. Blanchard. 1984. Movements and habitat use of the Yellowstone grizzly bear. Interagency Grizzly Bear Study Team Rep. 177pp.

Mattson, D. J. 1984. Classification and environmental relationships of wetland vegetation in central Yellowstone National Park. M.S. Thesis, Univ. of Idaho, Moscow. 409pp.

_____, and D. G. Despain. 1985. Grizzly bear habitat component mapping handbook for the Yellowstone ecosystem. USDI, Nat. Park Serv. - USDA, For. Serv. publ. 39pp.

Mattson, D., B. Blanchard, and R. Knight. (In press) Food habits of the Yellowstone grizzly bear. Presented at the 7th Int. Conf. on Bear Res. and Manage., Williamsburg, VA, Feb 19-26, 1986.

Mealey, S. P. 1975. The natural food habits of free ranging grizzly bears in Yellowstone National Park, 1973-1974. M.S. Thesis, Montana State Univ., Bozeman.

Picton, H., and R. Knight. 1980. Age and sex-related characteristics of grizzly bear (*Ursus arctos horribilis*) hair. Presented at Northwest Sect. Meet. of Natl. Wildl. Society, Banff, Alberta, 1980. 19pp.

Steele, R., S. Cooper, D. Ondov, D. Roberts, and R. Pfister. 1983. Forest habitat types of eastern Idaho-western Wyoming. USDA, For. Serv. Gen. Tech. Rep. INT-144.

Varley, J. D. 1983. The use of restrictive regulations in managing wild salmonids in Yellowstone National Park, with particular reference to cutthroat trout (*Salmo clarkii*). Pp. 145-156 *in* J. M. Walton and D. B. Houston, eds. Proceedings of the Olympic Wild Fish Conf. Sponsored by the Fisheries Technology Program and the Nat. Park Serv. Olympic Nat. Park, March 1983.

APPENDIX

Annual flight summaries during March through November, 1973-85.

					Unmarked grizzlies per hour		
	Total radio flights	Total radio flight hrs.	Total observation flights	Total obs. flight hrs	Radio flts.	Obs. flts.	Total radio locations
MAR							
1975	0	0.0	1	1.0	-	-	0
1976	3	4.3	0	0	-	-	11
1977	2	5.5	0	0	-	-	15
1978	6	13.6	0	0	-	-	56
1979	5	20.4	0	0	0.05	-	67
1980	3	8.8	0	0	-	-	20
1981	4	10.8	0	0	-	-	39
1983	3	3.2	0	0	-	-	15
1984	2	3.5	0	0	-	-	10
1985	1	0.7	0	0	-	-	3
APR							
1974	-	-	3	9.4	-	-	-
1975	-	-	4	9.3	-	0.32	-
1976	7	11.6	-	-	0.35	-	19
1977	8	26.4	-	-	0.11	-	55
1978	7	17.5	-	-	0.06	-	57
1979	4	21.4	1	4.0	0.05	-	36
1980	7	19.2	-	-	0.47	-	54
1981	6	15.7	-	-	-	-	54
1982	3	9.0	-	-	0.44	-	25
1983	7	16.4	-	-	0.12	-	41
1984	5	10.8	-	-	0.65	-	23
1985	5	9.3	-	-	-	-	29

Annual flight summaries during March through November, 1973-85 (continued).

	Total radio flights	Total radio flight hrs.	Total observation flights	Total obs. flight hrs	Unmarked grizzlies per hour		Total radio locations
					Radio flts.	Obs. flts.	
MAY							
1973	-	-	3	12.0	-	1.33	-
1974	-	-	6	18.1	-	0.83	-
1975	1	2.5	8	14.3	0.40	0.21	1
1976	10	23.1	-	-	0.22	-	21
1977	8	27.6	-	-	0.36	-	61
1978	4	13.8	-	-	0.15	-	36
1979	7	34.8	-	-	0.26	-	64
1980	7	30.1	1	3.0	0.53	1.67	71
1981	7	27.3	-	-	0.26	-	69
1982	4	11.8	-	-	0.34	-	40
1983	8	15.6	12	35.7	0.06	0.28	42
1984	7	15.6	-	-	0.13	-	26
1985	9	21.8	-	-	0.14	-	43
JUNE							
1973	-	-	5	19.3	-	0.52	-
1974	-	-	12	38.9	-	0.57	-
1975	1	2.7	2	1.4	1.48	-	1
1976	7	15.6	2	6.3	0.83	2.22	18
1977	11	48.1	-	-	0.23	-	110
1978	12	50.9	-	-	0.08	-	92
1979	7	41.9	1	4.8	0.12	0.21	64
1980	10	32.1	-	-	0.44	-	69
1981	10	42.9	-	-	0.14	-	72
1982	7	25.9	-	-	0.23	-	63
1983	5	13.3	16	43.4	0.30	0.30	34
1984	15	46.0	-	-	0.22	-	82
1985	6	19.8	-	-	0.61	0	49

Annual flight summaries during March through November, 1973-85 (continued).

	Total radio flights	Total radio flight hrs.	Total observation flights	Total obs. flight hrs	Unmarked grizzlies per hour		Total radio locations
					Radio flts.	Obs. flts.	
JULY							
1973	-	-	4	13.1	-	1.76	-
1974	-	-	11	30.5	-	1.48	-
1975	3	5.2	9	21.2	0.39	0.67	5
1976	12	32.5	-	-	0.19	-	31
1977	10	45.7	-	-	0.48	-	103
1978	7	34.8	-	-	0.03	-	60
1979	10	62.9	4	20.0	0.11	0.35	95
1980	9	43.4	5	24.3	0.09	0.91	111
1981	8	28.4	4	19.0	0.25	0.68	68
1982	7	33.4	4	16.3	0.21	1.17	69
1983	7	30.9	7	21.1	0.16	0.33	45
1984	13	42.6	8	22.2	0.45	1.22	97
1985	7	23.1	7	16.8	0.26	0.66	45
AUG							
1973	-	-	3	9.5	-	-	-
1974	-	-	7	19.9	-	1.86	-
1975	13	36.7	-	-	0.08	-	31
1976	13	43.4	-	-	0.46	-	73
1977	8	35.7	-	-	0.03	-	80
1978	12	59.3	-	-	0.03	-	109
1979	14	75.4	1	3.5	0.15	1.71	131
1980	9	29.7	-	-	0.24	-	72
1981	17	52.5	-	-	0.50	-	142
1982	17	49.1	2	8.8	0.08	0.46	115
1983	12	34.1	6	24.1	0.18	0.25	68
1984	16	42.5	3	6.8	-	-	95
1985	6	17.9	6	11.0	-	0.91	31

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Annual flight summaries during March through November, 1973-85 (continued).

	Total radio flights	Total radio flight hrs.	Total observation flights	Total obs. flight hrs	Unmarked grizzlies per hour		Total radio locations
					Radio flts.	Obs. flts.	
SEP							
1973	-	-	3	7.9	-	0.25	-
1974	-	-	6	16.8	-	0.06	-
1975	12	31.5	-	-	-	-	44
1976	12	60.6	3	12.2	-	1.31	113
1977	13	63.9	-	-	0.28	-	138
1978	9	36.0	-	-	0.03	-	82
1979	15	49.9	-	-	0.06	-	79
1980	9	28.7	-	-	-	-	56
1981	11	36.5	-	-	0.16	-	93
1982	12	45.9	-	-	0.07	-	99
1983	16	41.0	-	-	0.02	-	89
1984	9	32.3	-	-	0.06	-	70
1985	4	8.3	-	-	-	-	15
OCT							
1973	-	-	5	11.9	-	0.67	-
1974	-	-	5	12.7	-	0.63	-
1975	8	13.8	-	-	0.07	-	40
1976	9	36.3	-	-	-	-	56
1977	18	49.4	-	-	0.22	-	126
1978	10	50.4	-	-	0.02	-	117
1979	11	39.2	-	-	0.08	-	86
1980	10	30.2	-	-	0.03	-	88
1981	9	28.1	-	-	0.04	-	71
1982	9	20.0	-	-	0.10	-	59
1983	9	13.7	-	-	-	-	55
1984	9	24.7	-	-	0.04	-	75
1985	7	18.1	-	-	0.11	-	43

Annual flight summaries during March through November, 1973-85 (continued).

	Total radio flights	Total radio flight hrs.	Total observation flights	Total obs. flight hrs	Unmarked grizzlies per hour		Total radio locations
					Radio flts.	Obs. flts.	
NOV							
1973	-	-	1	2.18	-	-	-
1975	4	5.7	-	-	-	-	19
1976	7	15.9	-	-	-	-	44
1977	9	19.2	-	-	-	-	52
1978	5	20.8	-	-	0.05	-	61
1979	10	30.8	-	-	-	-	78
1980	7	16.6	-	-	-	-	43
1981	6	14.9	-	-	-	-	38
1982	4	8.1	-	-	-	-	22
1983	1	1.5	-	-	-	-	2

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